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The
GEOGRAPHICAL JOURNAL

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A CAMEL JOURNEY ACROSS THE RUB' AL KHALI: *A paper read at the Evening Meeting of the Society on 18 May 1931, by*

BERTRAM THOMAS, O.B.E.

THIS is the third occasion on which I have had the honour of addressing a paper to this Society on the subject of the great desert of Southern Arabia —Rub' al Khali. The first camel journey I made in the winter of 1927–28 through the south-eastern borderlands for a distance of 600 miles; the second journey, made northwards from the central south for a distance of 200 miles to the edge of the sands the winter before last, formed the subject of a paper read to you by Sir Arnold Wilson. Both these journeys were undertaken on my own initiative and not under any official auspices: in order to do them I grew a beard, donned Arab clothes, and lived as one of the Badus themselves, but did not conceal my race or religion. They were undertaken as part of a piecemeal scheme of exploration of the unknown south and also as preliminary reconnaissances for a final attempt on a desert crossing. The realization of that journey is the subject of this paper.

It is scarcely necessary to say that interior Arabia for the European and Christian is still a forbidden land. The traditional British official attitude, the attitude of the Treaty chiefs, and of the inhabitants themselves is a common one of opposition to any outside intrusion. This attitude, in the light of insecurity and religious fanaticism within, is immediately intelligible. No authority will, or can be expected to, allow itself to be actively involved in the responsibility for life or property in such a land. To ask for official approval to a scheme of exploration is thus to invite refusal if not prohibition. Thus it was that this rather forbidding part of Arabia had not engaged the serious attention of any one since Burton's forlorn attempt to obtain official sanction for his aims eighty years ago.

As a result of having spent the past thirteen years in various political capacities in Arabia, an experience that kept me in very close touch with the tribal Arab, I acquired a facility in his language and a knowledge of his ways which it would have been inexcusable not to apply to solving this last considerable Arabian problem that confronted us—the exploration of Rub' al Khali.

On completion of my second journey I had entered into a secret arrangement with one of my party, an influential member of the Rashid tribe, to bring a

caravan to the coast to meet me in the early succeeding winter, *i.e.* last winter. The promise was sealed with a present of £20 sterling. This man undertook to take me to a point in the sands where occasional Murra tribesmen were wont in favoured years to come from the north. The idea was that I should make my way by being passed on from tribe to tribe, an experience I had thrice known on my first journey through the south-eastern borderlands in 1927–28.

On October 6 last I quietly disappeared from Muscat. Dhufar, in the central south, was my immediate objective. There, I hoped, the promised caravan would be awaiting me. No one in Muscat knew of my plans or movements except the Heir Apparent in the absence of the Sultan, his father, for my plans required the utmost secrecy. Exposure would, in all likelihood, have raised the countryside ahead of me. The news would have spread, as all news does spread in Arabia, at an alarming pace and with undesirable accretions. The suspect spy would be barred entry or exit. To ask a Badu's permission to visit his habitat, the waterholes and pastures of which are his chief possessions, is generally to invite refusal. To arrive unheralded connotes in his fatalistic mind, one dares hope, an event in accordance with the Divine Plan.

I put off from Muscat at midnight in a small sailing boat flying a red flag. This, by a prearranged plan, was the sign by which a passing oil tanker due at dawn on the morrow would know me. The S.S. *British Grenadier* homeward bound duly picked me up and dropped me the following night into an Arab dhow off the south coast of Arabia. There, in Arab kit, I landed at Risut and made my way quietly to the Sultan's fort at Salala, the capital of the Dhufar province. My first thoughts were of my hoped-for caravan. Devious inquiries showed, alas! that it was not there. And no one had heard since last year of Sahail the Rashidi on whom my hopes of penetration were fixed. My plans had miscarried; and the reason—war was in the air. The great Sa'ar tribe of Hadhramaut, the hereditary enemies of the Rashid, were on the warpath. The countryside was up. The road was barred. No caravan had come out of the sands, nor, it seemed, could it come.

Here, at the outset, I was to find myself up against an immovable obstruction. To penetrate Arabia requires a caravan able and disposed to carry you. The other two main obstacles to penetration, the traditional official attitude and insecurity from raiders or treachery, could be met by being ignored, but you cannot move an inch without knowledgeable companions and good and sufficient camels. My previous experience had taught me that my plans could be achieved only through the medium of a Rashidi caravan. The great desert is usable only by men and camels that have been born and reared in it. None was available. I could have raised a local caravan of last year's personnel or its like and animals from the Dhufar mountains. I knew from experience they would get me nowhere. Delay was inevitable; the prospect of a move forward distant and uncertain.

I searched out two members of the Rashid tribe who had come to Dhufar for the frankincense season. I took them into my confidence. To each I promised the present of a camel as earnest of more to come for a successful mission, and so despatched them off secretly into the sands. This plan was disclosed to no one else, not even to the Governor of Dhufar, who had been instructed vaguely to help me. For the Muscat connection does not extend beyond a strip of

coast, wherefore to identify oneself too closely with it, or indeed with any other external authority, may lead to misconceptions about one's motives. Success was, indeed, to be best attained only by allaying all suspicions of ulterior motives. Contributing to this end was a personal reputation I had acquired as a result of successful journeys I had already made with members of nearly every tribe in the eastern and southern borderlands. I had dressed as they, lived as one of them, ridden and hunted with them, shared with them the role of target for enemy bullets on three occasions, and not least, I had left prosperity in the shape of silver dollars and rations in my hungry path. This reputation and my parting present to the Rashidi of last year's expedition were to prove profitable investments, for in response to my messengers a caravan of thirty men I had never seen before came 200 miles out of the southern sands at my secret beckoning to run the gauntlet of their enemies, the Sa'ar to boot. But two long months elapsed before they arrived, and as the weeks passed I feared the effect of the growing talk in the town about my suspect aims. I thought my messengers had been intercepted by a Sa'ar raiding party and scuppered, and I should see them no more. I had become quite resigned to the impossibility of my cherished plans.

Dhufar is not improbably the Biblical Ophir from which Solomon derived his gold and frankincense. The crescent plain where it edges the sea is marked by a long coconut grove, and is also studded with the remains of ancient cities. There is no considerable mound on the Babylonian pattern. Perhaps this could be explained by the probability of continuous occupation from the dawn of history, judging by its uniquely favoured position in relation to the south-west monsoons, and if so, it would seem that much of the old building material has been re-used by successive ages. The most characteristic architectural feature of these ruins is a plain primitive column, generally a monolith, with octagonal shaft, square corbelled cap, and square base. It is usually about 6 feet high, and this and its corbelled cap suggest that it supported arches. Arched masonry does in fact lie strewn about amidst the debris, and an arch probably of a post-Islam period still stands. Bent connects the Dhufar column with columns he saw at Adulis on the Red Sea, and with those of Kulue and Aksum in Abyssinia, and says that no doubt can be entertained that they were built by the same people. I mention this as being one of many points of contact between South Arabia and North-East Africa.

Beyond the coastal plain here, some 8 miles wide, lie the Qara mountains, a belt of Upper Cretaceous and Eocene limestone rising to a height of 3000 feet. The wet monsoon of India here makes its first call, and a three months' continuous rainfall on the seaward face of the Qara mountains gives this area a luxuriant flora which nowhere finds a counterpart throughout the length and breadth of Arabia. Thick forests of deciduous trees, comparable in size with those of an English wood, luxuriant figs and sycamores and giant creepers adorn the seaward valleys and hill slopes; above are roofs of rolling yellow meadows, sometimes of wild oats, where rich herds of cattle form man's chief possessions. Into these mountains I turned aside to explore while I awaited the desert caravan which might or might not turn up. Apart from the cloak that was thus afforded to my secret and more ambitious plans, it provided opportunity to carry on certain anthropological and philological investigations

in which for many years I had been deeply interested, and to make a collection of the fauna for the Natural History Museum.

The language, culture, and physiognomy of these mountain people of South Arabia mark them off very distinctly from the northern Arab. Indeed, if the hawk-nosed, long-headed Semitic type of northern Arabia is regarded as the true Arab type, I feel that the inhabitants of the south, not merely of the Dhufar mountains, but tribes to east and west, represent certain definite non-Arab survivals. I have already on a previous occasion suggested reasons for believing either that these tribes had in part an African origin or else that the southern Arabian and some of the north-east African tribes sprang from a common origin. I took cranial callipers with me and made some fifty head measurements, heights, and fathoms, and took a full-face and profile portrait of some fifty specimens. This material is the first of its kind to be brought back from this part of Arabia, as the native dislikes being pawed by infidel hands, and in many cases refuses angrily even to be photographed. I hope it will enable anthropologists to tell us more about South Arabian racial affinities than was known before. My paper "The Anthropology of the South Arabian Desert" is about to be published in the *Journal* of the Royal Anthropological Institute.

The caravan arrived—thirty men and forty camels, including *rabias* of the Karab and 'Awamir tribes, an insurance against our being molested by the raiding of these tribes if we encountered them. With the caravan came Salih bin Kalut, one of three shaikhly brothers of the Rashid tribe. I bound him to secrecy and then unfolded my plans. He answered that they were impracticable. He was prepared to accompany me into the southern sands, where his own tribe were located, and to bring me back to Dhufar *insha'allah;* but northwards lay the Murra tribe. He could not himself go there without Murra protection, he said, much less take me. In any case none knew the waterholes but the Murra themselves. I was insistent that either I must cross the desert or else would never embark. He was equally insistent that this was beyond his powers. For three days followed abortive conversations; but it was clear to me that he could not guarantee another tribe's cooperation, which was absolutely essential to my ends, and so I was obliged to be satisfied with his pledged word that he would genuinely work in my interests. My larger plans were kept secret from my present caravan: only Salih must know, though rations carried might excite their curiosity. The caravan had been recruited from the southern sands of Dakaka, and it would be dismissed there. Dakaka was indeed the key to the sands this year, for last year's rains (I had myself met with them in these southern borderlands) had endowed Dakaka with the most favoured pastures, and so thither the herds had now gravitated. Our course must therefore naturally lie that way—the way of green pastures. But I was quickly made to realize that one set of camels could not possibly cross these sands in the quick marches that I desired. Carrying loads, they could not stand it; they would lose condition. Indeed, Shaikh Salih considered that four relays of camels would be necessary, although in reality three sufficed. But that is anticipating events—the crux of the problem would be (i) the Murra attitude to my passing through their country; (ii) the presence of pastures this year that would make the journey possible; and (iii) the ability to find Badus prepared to risk their camels. The Murra attitude was at present indeterminable. It was in this

In the Qara mountains

Meadows below Khiyut, Qara mountains

Slave dance at Dhufar

Yafi' types: Southern Arabia

Shahari and 'Omani, with cobra

Qarowi, Shahari (Albino), and Shahari

uncertain mood, after being held up for two months, that I marched. The odds for or against Murra cooperation were judged to be even by Shaikh Salih.

We set out northwards on December 10. My Badus had received rations for twenty days, the time allowed to reach Khor Dhahiya, a famous waterhole, whence they had come and where, on arrival, man and beast after a 200-mile march to the coast and back, would be exhausted. There another caravan must be engaged. Pack animals were loaded with dates, flour, butter, and rice, intended for relay men's rations for six weeks. Rations were based on a progressive reduction of my party's numbers as I moved northwards, for it was the first phase of the journey that was most exposed to the danger of raids, and we needed, if challenged, to be able to give an account of ourselves. For financial reasons I would have preferred to cut my escort down to a dozen men, but the fear of raiders from the Hadhramaut, especially of the Sa'ar tribe their enemies, made my party unwilling to move less than forty strong, and indeed oddments attached themselves to us in the early stage of the journey without hope of reward merely for the protection that our numbers afforded. Raiding parties of two and even three hundred are not unknown in these southern borderlands, where plunder of camels and rifles and shedding of blood are among the normal activities of life. Here there is no ruling prince, nor ever has been, but men are a law unto themselves, and there normally prevails between tribes a kind of anarchy.

We crossed the Qara mountains that I have already noticed, and thence, at 2300 feet, just over the divide, passed through valleys of frankincense groves, not improbably the frankincense country of the Bible, and so on by way of Wadi Dauka across the gentle steppe to the waterhole of Shisur, six days' march to the north. This country I had explored and mapped in the previous winter (*G.J.*, vol. 77, pp. 1–28). Then I had turned north-east from Shisur to explore the southern border of the sands in that direction. Now I was to turn north-westward into the unknown. I had already despatched Shaikh Salih ahead of me from the Qara mountains to prepare another caravan over the next waterhole and to search out and enlist, if possible, the services of the Murra *rafiq* Hamad bin Hadi, who alone had the reputation of being able to guide me forward into the heart of the sands.

From Shisur westwards our line of march lay hugging the southern border of the sands, entirely waterless and with scant pastures. Gruelling days of nine and ten hours in the saddle through this hungry waste reduced our camels to a pitiful condition. Thus for nine waterless days. The southern sands form a mighty red bulwark where they border the steppe. A feature is the presence here and there of *ghadara*—large white surfaces which fill the depressions. They have the appearance of residues of dried-up lakes: the specimens I brought home have been found to be gypsum. Nearby, lying on the surface of the plain, in 18° 30′ N., 52° 45′ E., were many oyster and other fossils. Those I collected, Ostrea, Lucina, and Rostallaria, were much weathered; all appear to come from Middle Eocene limestone (see Appendix II.—N).

Transverse lines of sometimes isolated dunes ran across our path, and were said to follow the line of wadi beds, for the great wedge-shaped steppe which extends westwards between the Indian Ocean escarpments and the sand is crossed by a series of wadis falling from south to north, where, on the verge of

the sands, they disappear. Of such were Fasad, Mitan, Shu'ait, and Urba, whose heads we crossed. Westward at intervals of a day's march were reported Wadis Thumurat, Dhahiya, Thuf, Rama, Aiwat al Manahil, Jinab, Khadhra, Hazar, Aiwat as Sa'ar, and Hudhi, the last-named reported to be bearing due north of Tarim. These wadis are the habitat of the Kathir, Mahra, Manahil, 'Awamir (southern sections) and Sa'ar tribes, in an east-to-west order—tribes chiefly dwellers of the steppe. Conditions are too arid for the horse, the donkey, and the dog; caves and acacias take the place of the "tent of hair" which is the house of the sands. This steppe is the home of many wild animals, chiefly oryx and gazelle, and at one time of the ostrich. Members of my party had shot ostriches here, and I picked up fragments of petrified egg-shell, but it would seem that firearms and the pursuit of an unenlightened self-interest by the Badu have extinguished the ostrich, at any rate in the eastern marches I traversed. I collected a horned viper and two other snakes, also a specimen of the new lizard I had found on a previous expedition: oryx, gazelle, hare, and foxes were the commonest mammals, with traces of wild cat and badger. These are common to both steppe and sand, but whereas the large edible lizard and the red gazelle (*dhabbi*) belong properly to the steppe, the white gazelle (*rim*) is mostly confined to the sands. The oryx belongs properly to the steppe, though in winter after rains he penetrates, like many other steppe animals, into the bordering sands.

Here in the borderland between steppe and sands my Badus pointed out to me, in 18° 30′ N., 52° 30′ E., ancient caravan tracks which they called the Road to Ubar, an ancient city that, according to their legends, lies buried beneath the sands. On my previous journeys I had heard from other Arabs of the name of this Atlantis of the Sands, but none could tell me of even an approximate location. All memory of it had been banished from my mind when suddenly my companions pointed to the considerable tracks, about 100 yards in cross-section, lying in the hard steppe on a bearing of 325°. Ma'yuf, the most intelligent of them, volunteered the information that as a boy he had, while grazing in the sands of Shu'ait, come upon a large circular block of stone (drum of a column?) and numerous coloured potsherds. It would have been suicidal for us to have turned aside into what was now an arid pastureless waste, apart from the consideration of our waterskins containing a bare sufficiency of water to carry us along to the next waterhole. That the sands are encroaching southwards there can be small doubt, and the tradition of an ancient city is strengthened by these indubitable evidences of much caravan usage scarred in the plain, and the comparative proximity of the historically famous frankincense region. If, too, the climatic conditions have changed within historic times, and if there was an ancient overland trade route from the frankincense country to Gerrha on the Persian Gulf or to Petra of the Nabathaeans in Sinai, the location of Ubar hereabouts would not appear to be unreasonable. Can there be any connection between the words Ophir and Ubar by the change—a philological commonplace—of an *f* for a *b*?

Striking north-westwards we left the borderland sands of Shu'ait and entered the 'Uruq Dhahiya, a great immensity of dune country. Vast ridges rise to towering heights; about them are precipitous gorges. It is almost impassable. Again and again we were driven to dismount and to scoop footholds with our

hands in the soft yielding slope, so that our camels could climb. No pack animal but a camel could traverse the 'Uruq, as such sands are called, and certainly no motor car. There is an exquisite grandeur in the scenery, a noble Alpine architecture in a pure smooth old-rose red colour. It is in such rugged sand-dune regions that singing sands are to be encountered, and here I met the phenomenon. As we moved along a sudden droning noise commenced; a cliff of sand, topographically called "Khait," on our right hand, at about 100 yards, was pointed out as the source of it. The hour was 4.15 p.m., and a light northerly wind was blowing from the back of the cliff. The bellowing, for such it is rather than singing, was not unlike the syren of a moderate-sized steamship; of surprising volume, it continued for about two minutes and ended as abruptly as it had begun.

A nine hours' march on Christmas Day brought us to the towering sands above the *huta* (sand valley with pasture), wherein lay Khor Dhahiya, the much-desired waterhole where man and beast would find refreshment, and where I hoped to come upon Shaikh Salih, the Murra guide, and a fresh batch of camels. Our own camels were completely exhausted, and we should certainly have lost most of them if obliged to press on with full loads for many days more. We halted for the night on the crest of a sand-ridge 300 feet above the *huta*. Two of our Badus rode on down to skirmish for friend or foe. They examined the waterhole and came back with the news they had found recorded on the face of the sands. Good news it was. No enemy had been there, but a member of the Rashid tribe had visited it yesterday presumably in the expectation of meeting us, for were we not arriving a day late? The failure of Shaikh Salih to keep his appointment admitted of many constructions. Khor Dhahiya is an unsafe spot, for the raider from the steppe knows of it and comes this far on his bloody missions. It is, in short, unhealthy to loiter over this waterhole in such times as these if your numbers are few. There was little pasture here, but good pastures reported a day ahead. We spent the morning watering and then pressed on. By and by the footmarks of the Murra guide and his camel were identified in the sands by the Badus, and a little later those of other Rashidis, including Shaikh Salih. These we followed, and so next day came up with the object of our quest—men and camels over comparatively fat pastures.

The reading of the sands is a science known to every Badu. Every living creature—man, his camel, the wild animal, the reptile, and the bird that alights—these all leave their distinguishing marks in the surface of the sands. Such remain for variable periods, according to winds, but time effaces them ultimately. The definiteness in the foot or claw impression dates it, and so the sands have no recent secrets. The Badu will tell you by the impression of the camel's hoof when its author passed, whether it was a cow big with calf, whether a camel in good riding condition, or much other information. He knows the impression of every man and animal of his tribe and many of his enemies.

To the man lost in the desert, following the trail of others is regarded as a safe thing to do. It must lead to water. So also the raiding party from the steppe. They may pursue others into these southern borderlands, count reasonably on coming to water, which the pursued cannot in any case do without, and return on their own tracks. Their great dread is the sudden springing up of a high wind that will obliterate their own tracks, and so obscure

the line of retreat. It is but seven years ago a party of Mahra were raided by two members of the Manahil who made off with ten camels. Discovering the loss while the tracks of the retiring raiders were still discernible, seven Mahra stalwarts went in pursuit, and the tracks brought them to these sands of Dhahiya, previously unknown to them. On came the bold pursuers, who reckoned upon the pursued having to halt over a waterhole where they too would water. But the Manahil, prudently fearing pursuit, avoided Khor Dhahiya and went ploughing on northwards through these deathly sands. One man alone, cunningly going off at a tangent to the waterhole to fill his waterskins and returning by the same track, obliterated his own few tell-tale tracks where it was necessary, and so refound his companions. Thence they proceeded. The Mahra, following hopefully on the main camel tracks of Manahil, were certain that their thirst would soon be quenched, but before they could overtake their despoilers a sandstorm came and obliterated all tracks before and behind them. The Mahra were now lost in the sands. It was one of my own party of Rashidis who some six months later had come upon their seven skeletons and the bones of their camels in the sands.

Not even the Badus born and bred in the sands are all of them guides. Certain border sands are universally known, but in the remote *hadh* areas, whither men are driven in times of drought, cases are known, especially in summer, when single Badus, moving off the beaten track in pursuit of strayed camels, lose their way and perish of thirst.

With my party reduced in numbers to twenty men, all strangers to me again, I pressed westwards through these sands of Dakaka. Shaikh Salih had almost immediately left me to go ahead again and arrange the third caravan. The rendezvous was to be Shanna, a deep waterhole in western Dakaka, and the day fixed ten days ahead. We deliberately made slow going, amidst improved pasture and sufficient waterholes. I could now find more opportunity for natural history collecting and photography after their comparative neglect during the recent long, hungry, barren, forced marches. One had in any case to be recording data of the route traversed and of meteorological readings. I came equipped with prismatic compass, aneroids and a hydrometer, sextant, artificial horizon and chronometers, surgical instruments for skinning, killing and preserving bottles, a 7 mm. Winchester rifle and butterfly net, cranial callipers, and two cameras, including a small 16-mm. kinematograph. Collection of specimens of water, sand, fossils, and animals meant increased weight as I went along, for which diminishing rations was an offset. I had not brought a tent with me from considerations of weight. The cold at night was bearable; sleeping out of doors in temperatures usually falling to 55° F. I slept in all my clothing in the manner of my companions, but plus three blankets, which the poor shivering wretches were without. My routine was to make a traverse by day and adjust it by latitudes taken by night. For food I depended primarily upon camel's milk, though I took a limited supply of cocoa, meat extract, biscuits, butter, and malted milk tablets as transport conditions allowed. Ordinarily the Badus of the sands live exclusively on camel's milk with an occasional meal of camel's meat. But the cow in milk is not ideal for long forced marches across the desert, wherefore I carried hard rations for my party, and only two camels in any of my camel relays were in milk: these for myself.

We came to Shanna, the rendezvous in western Dakaka in 19° 00′ N., 50° 45′ E. approximately, altitude 990 feet. This was the strategic point for the crossing. I was, thanks to last year's rains, here able to take off with a fresh party of men and animals, thirteen Badus, and five pack animals, all in good fettle for my dash across the sands. My traverse and astronomical positions showed that Qatar, my hoped-for objective, lay 330 miles on a bearing somewhat east of north. I had twenty-five days' rations left for my party. It was none too much; to loiter in these parched sands would mean death. The health of camel and man was devoutly to be desired. Long sharp marches must be the order of the day. Loss of camels, sickness, or treachery of our guide or other members of the party, or meeting with an enemy, would have spelled tragedy. Camel pastures before us were indeterminable, but the supreme consideration. If we found none, we must turn back while men's rations were yet sufficient. Not to do so must lead to disaster. At no time could I afford to halt in the middle of the day and dismount for lunch. In these hunger-stricken wastes the great consideration is to get out of them as soon as possible. Eight or nine hours in the saddle day after day is imperative, the only justification for halts being when camel thorn is come upon and you graze your animals, or for Muhammadan prayers—always punctiliously observed. I started off each morning with a flask of camel's milk, and this was the only sustenance I had throughout the long day. Hunger and thirst were tormenting for the first few days, but not afterwards. I kept fit throughout my two months' journey, but lost a stone and a half in weight.

We left Shanna in January for the northward dash. Hamad bin Hadi alone of my party, except for a newcomer, Talib, also a Murri, knew the sands before us in this longitude. He was famous for raiding the noted Sa'ar tribe and had slaughtered them with his own hand. He had also inherited a blood feud with the Manasir, with whom his father had been on no better relations. Hamad was thus haunted by many ghostly fears, and in these southern sands was ever watchful. We had had alarms coming along, and with Hamad as an advance guard we would now and then be called upon to halt during the day's march, while he crept forward, making use of sand cover, towards any distant object that looked like an enemy and must be spied out. The stump of a bush on a sandhill gave us more than one fright. When halting for the night Hamad too would borrow my telescope and go back over our line of march to ensure that we were not being tracked by an enemy, and he would return after dark, when tracking is no longer possible (except at times of full moon), and the camp felt safe on that account. It was fortunate to have secured a Murri of Hamad's standing in his tribe and a guide withal. Without him I doubt whether I could have moved safely a yard into the Murra habitat.

The Badus are attractive companions despite their religious frenzy. If they pray punctiliously and have frequent outbursts of religious piety, there is nothing mealy-mouthed about them. They are realists. They shed the blood of their enemies without the flicker of an eyelid, and camels plundered in the raid give no qualms of conscience, for they are the spoils of war and not ordinary theft; but between friends there is a fine spirit of comradeship.

They wear the familiar tattered rags of the familiar Badu: their food is almost exclusively camel's milk—only the Murra in the north have long dogs

and hunt fox and hare for the pot. They live in camel-hair tents, and marry, for economic reasons, generally only one wife. Theirs is a nomadic life, with man the parasite of the camel. They gravitate with their herds to the best pastures and are always on the look out for signs of rain. The rule is to eat up the pastures of one area and pass on to another, and so on in unending circle. When wandering off to remote inaccessible regions they split up over wide areas, each family living unto itself; but when, as last winter, the good grazing is in the south, and they then are exposed to the raiders of the steppe, the tribe for self protection huddles together. In summer, when camels require frequent, if not daily, water, they will be found never far from waterholes; in winter they may move off after fresh pastures and stay away from water for a month or two on end. This is the cause of the hatred, often militantly expressed, of the Wahhabi Puritans of Nejd. For the religious rules of Islam lay down that after the normal daily acts of the body, including sexual intercourse, the body must be washed before prayer, else is the prayer null and void. In these waterless wastes sand is substituted for water, wherefore nomadic life is irreconcilable with true religion, and the nomad becomes an object of execration. Only two sections of the Murra are Wahhabi, the rest are Hanbali, one of the four orthodox Sunni sects of Islam. The Rashid, on the other hand, like all the great tribes of the south, are Shaf'i. These two tribes, occupying respectively the southern and northern sands, moreover speak different dialects of Arabic, and their chanting would appear to belong to different schools.

The Badu has some attractive qualities. He considers himself no whit your inferior or any man's inferior. Virility is the keynote of his character. He sets great store by manly qualities—valiance in war, skill in riding and shooting, and the exercise of resigned patience when faced by hunger and thirst. He is a cheerful companion. His pet subjects of conversation are rifles, raids, camels, religion, and women. Women are veiled; they are chattels; his conversation about them is of an unblushing kind.

Passing northwards out of Dakaka we entered Suwahib, a regional name of the sands which stretch as far as the 22nd parallel in these central wastes. The word, like other regional names in the sands, has a topographical significance. Sahiba, of which it is the plural, stands for sand-ridge, and Suwahib is in fact a region of parallel sand-ridges some 80 or 100 feet high and a few hundred yards apart, between which are shallow troughs of hard red sand. The axis of these ridges is roughly north-east, so that our more northerly course took us diagonally across them. Here for the first time I met a tiny encampment of camel-hair tents and small herds of camels. They belonged to the Murra, who are famous for their black-coloured animals, though the Murra would not normally have been met so far south as this. My Rashidi Badus had been disinclined, for reasons they kept to themselves but not obscure to me, to take and show me their encampments, whereas I was allowed to descend here and talk to the kinsfolk of my Murra guide.

Passing out of Suwahib we entered Mazariq, where the sands were in doldrum mood in contrast to the more stormy moods of the south. The aneroid had shown a gradual fall in elevation from 900 feet in Dakaka to 550 feet here. The terrain here, as behind us, and before us, was rising westwards and falling eastwards. There was a change of flora. The richer camel

fodder *abal* and *zahar* (*Tribulus alatris, Del*) was left behind. We had entered a *hadh* belt (*Salsola* sp.), a saline bush which has the property of enduring longer than any other growth of the central sands during rainless years, so that in times of drought *hadh* areas alone support life, and here the sand tribes are to be found, unless indeed they are driven out of the sands altogether into the steppe borderlands.

It was in these central sands that we dug out a fennec fox of a species believed to be new, and here that I collected two eagle's eggs from a nest, though unfortunately I did not see the bird, which thus cannot be identified with certainty. The eggs have been carefully compared with those of the Abyssinian tawny eagle (*Aquila rapax rapton*) and agree with them very closely. This eagle is found from the Soudan and Abyssinia to Somaliland and South-West Arabia. The fox and hare are the commonest mammals of the sands, with a desert rat and a wild cat. The most persistent bird throughout my march was the fantailed raven. Bustard were numerous, judging by sand impressions, but they are shy of man and usually took to wing before we could get close to them. I had not on this expedition opportunities to collect birds. This was the more regrettable because I was thus singling out for neglect the department of Mr. N. B. Kinnear, through whose personal interest and encouragement I learnt to become a collector for the Natural History Museum. Of mammals, reptiles, and insects I collected some 550 specimens, the details of which are given in Appendix II. Four hundred and fourteen were collected in the Qara mountains in the central south. A point of much interest about them is that they show African rather than Oriental affinities. The 135 specimens from the Rub' al Khali proper, on the other hand, are almost entirely palaearctic.

Our course through Dakaka and Suwahib had veered towards the north-east. It was thus calculated by my Badus later to circumvent the fanatical *Ikhwan* tribes who live in the north. There had been no lack of water, albeit water almost unfit to drink. It was often the colour of beer and tasted strongly of sulphur. Specimens of the water of every hole used were brought back and a chemical analysis of them is given in Appendix II.—P. I did not drink it myself except when extremely thirsty, as I depended on camel's milk for the most part for my diet, but even camel's milk is brackish when the camel is grazing on saline pastures. My men and beasts now began to suffer from the effects, wherefore this north-easterly course of ours was turned to north-west, which took us into the sands of Sanam. There the water would be deep and sweet. Sanam is one of the biggest *hadh* sand areas and is used chiefly by the Murra tribe of the northern borderlands. The meaning of the word is "camel's hump," and this is rather appropriate, in that as you approach northwards the aneroid quickly registers a fall of some 250 feet in elevation, though no such descent is discernible to the senses. Western Sanam is called Tuwal, because of the fact that its wells are abnormally deep, *i.e.* 15 to 19 fathoms: this in contrast to the shallow waterholes of Suwahib. (In the south in times of panic it is the practice to fill up waterholes to obstruct a possible pursuer.) Here famous black Murra herds are wont to come: indeed, one saw recent tracks of these leading to waterholes and got distant views of the herds themselves, but my Badus were not for giving me a closer view. It would have been fatal if news had got ahead and so caused alarm or obstruction to my progress.

Deep wells in these sands are a cause of much loss of human life in their digging and cleaning; their soft sides are prone to slip in and entomb the miners, for no better revetment avails than the inadequate branches and roots of midget sand flora, and there is no tree properly speaking throughout the length and breadth of the sands proper.

And so we came to Banaiyan, the northernmost limit of Sanam, as it is the southern and eastern limit of the respective regions of Jiban and Jaub. The first stone-lined well on our route, Banaiyan is regarded by the natives as the northernmost limit of Ar Rimal proper, though in point of fact sands do occur spasmodically to the northwards, notably Jafura.

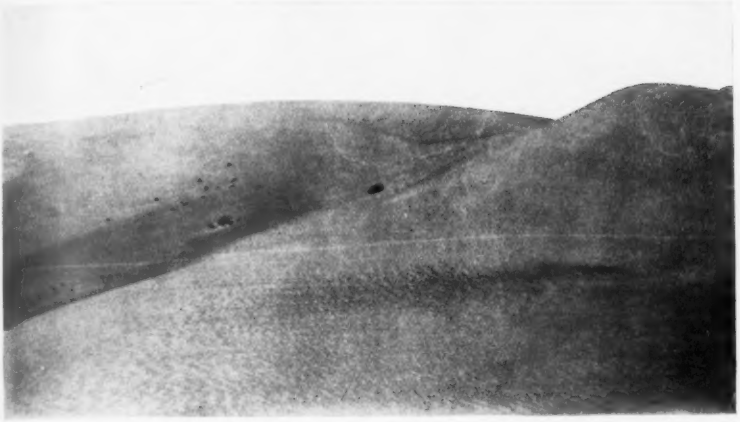
The belief hitherto held that the sands would prove to be utterly uninhabited and waterless has been shown to be illusory. Water there is in these sands, at least to the eastwards of 51° E., in which longitude roughly I crossed them, though, as I have shown, the water is extremely brackish, and in places cannot be used even with the camel as a filter, for the camel will not drink it. Where it is humanly drinkable, waterholes enjoy individual names: where it is exceptionally brackish, *e.g.* in the low sands of Eastern Suwahib, found everywhere at an arm's depth, so that a sand wolf can paw a hole to reach it, waterholes are labelled with the generic name *Khiran*. But whatever the condition of the water, settled life is nowhere possible throughout these sands, but only a nomadic existence where man lives on the camel. The chief consideration is pasture, and good pastures are nowhere perennial and sufficient. Vast tracks of desert are at any one time utterly destitute of herbage, and the abode of death for him who loiters.

The true inhabitants of the sands number a few hundred of Ar Rashid and Bait Imani, sand sections of Al Kathir in the south, a few hundred Manasir and 'Awamir tribesmen in the north-eastern sands, and maybe a thousand of the Murra tribe in the north and north-western sands. These tribes in greater or smaller degree penetrate into the remoter central sands in search of grazing, following rains in them, when rains have not fallen in their own borderland habitats. Localities may then be favoured once in many years. Thence they have come to enjoy regional names, as also do the waterholes within them, where they are sweet enough to enjoy the distinction.

Listing and sifting these region and waterhole names of Rub' al Khali has been a hobby of mine for some years, and my three journeys, culminating with the desert crossing last winter, have enabled me to locate them on the map, some with precision when on or near my route; the distribution of the others has been estimated.* The task of filling up what before was a blank map representing territory as extensive as Germany and France together is one whose inherent difficulties will be apparent. It must be remembered too that the first impulse of the Badu questioned about his poor but precious possessions—the secrets of water and marshes—is to cloak or dissemble. The European traveller who thus makes a lightning visit to Arabia, passes quickly over a route and records what he is told, will be showing some disregard for Badu mentality.†

*See Appendix I.

†Burton called attention to the map name (in his time) Ma'adri, denoting a village in the Middle Euphrates. Ma'adri is the Arabic for "I don't know!" And Ras Khaluf (thus it is known to the local Arabs), a possible South Arabian site of a seaplane station



Southern sands: camel scrub on edge of steppe

Southern sands: showing typical gypsum bed

Southern sands: Dakaka

Central Southern sands: Suwahib

Central Southern sands: digging a waterhole

Central Southern sands: watering camels

In saying this, no superior claims are being made for the accuracy of my map, compiled as maps of interior Arabia can only be compiled, but merely to mention that it is the protracted work of six years of one who has enjoyed opportunities of studying Arab dialects and psychology *in situ*, and of being in a position to collect information from many sources (as regards the Eastern sands), as a method for finding the highest common factor.

Apart from filling up the map, the geographical objectives of my journeys were (i) to discover the drainage of the southern part of the peninsula, which had up till now been obscure; and (ii) to collect fossils and other geological specimens showing formation and age. As regards (ii) a note on the rocks by Dr. Campbell Smith is given in Appendix II.—O. As regards (i), the slope of Rub' al Khali is now determined. The perimeter of the sands, at least on the south and east sides, is as shown on my map. The eastern edge of these sands is falling from north to south. Its altitude in the 'Oman peninsula is roughly 1500 feet; in the latitude and to the west of Ibri it is something less than 1000 feet; at Mugshin 400 feet. The slope of the peninsula in long. 51° E. is just the reverse, namely, it is falling from south to north. Dakaka is 900 feet, Hadh Mazariq 550 feet above sea; but Nakhala 70 feet below sea-level. The slope of the long axis of the southern borderland sands is rising from east to west. Mugshin is 400 feet; the confluence of Dauka and Umm al Hait 750 feet; Dhahiya 1100 feet, and thus the land is presumably rising westwards. Cheesman found Jabrin on the north-west of the sands to be 600 feet, and Philby found Sulaiyil to the middle-west of the sands to be 600 feet. These considerations, taken together, point to the highest part of the sands being found in the south-west.

It would appear that there is a depression in the south-east of the sands. Water comes to the surface at Hamaidan and Mugshin. This depression is probably in long. 54° to 55° E., lat. 20° to 22° N. East of this depression the slope is upwards towards the north-east to the 'Oman massif, rising to a height of 10,000 feet. West of the depression the peninsula rises towards the south-west, and probably the sands reach their greatest height on the borders of the Nejran. The middle and western sands are falling to the shores of the Persian Gulf.

Emerged from Ar Rimal at Banaiyan I was still divided from the sea by 100 miles of alternating sandhills, desolate quarrylike country, and ribbons of salt plain which are Jiban. But it was wise to halt for a day to write up my notes, because once embarked we should be in the habitat of the Ikhwan, where loitering would be dangerous, and we must avoid collisions at all costs. Fortunately, the month was Ramadhan, when they were likely to have withdrawn to distant oases to fast, as they are wont to do in this holy month, in the bosom of their families. But it was necessary to be prepared for contingencies, so that there was an understanding that if we met traces of them in our path we would halt by day, and move under cover of darkness. Fortunately for my map-making this proved to be unnecessary.

During the past week we had encountered severe sandstorms and intense

of the future, is marked on our Admiralty charts to-day by the figment Ras Abana, *i.e.* Cape of our Fathers.

cold: at least 35° F. seemed abnormally cold sleeping out of doors without overhead covering at the end of an exhausting camel journey. The blinding sand-laden wind and the impossibility of keeping a camp fire alive forbade sleep, and camels and Badus huddled together for warmth. But beyond making progress impossible, these sandstorms of South Arabia have none of the tragic terrors which one has associated with those of African deserts. The only casualties I experienced were my kinematograph camera and one aneroid, into the mechanism of which the sand insinuated itself, though sand grew up during the night a foot or more to embed like drift snow my saddle, boxes, and other obstructions.

The steppes of Jiban were dusted with gravel of jaspar and gypsum, small polished pebbles of red and white and jade; the crusty saltplains were studded by innumerable small shells in varying degrees of petrifaction. For a list of these, see Appendix II.—M, O.

In the drearier country between I saw tracks of wolves and hyenas, but there was no time to hunt them, nor were my tired Badus in the mood. The camels too were exhausted, for the pastures here in these northern latitudes *haram* and *shinan* (*Arthrocnemum glaucum*, *Ung.*) were even more saline than *hadh* had been and were most disturbing to our camels, unused to them, and which now required watering every day. Waterholes were numerous in the Eastern Jiban at half a fathom depth, and hence called Aqal: thus the Aqal of Jiban is the converse of the Tuwal of Sanam.

Approaching the base of the Qatar peninsula the aneroid gave below sea-level readings during two or three days' marches in the Nakhala area. Here in a quarrylike wilderness we came upon a salt lake. Sabkhat al 'Amra, as it is called, was about 7 miles in length and 1½ miles wide. Where we skirted its northern side it was bordered with a 20-foot belt of rock salt, specimens of which were collected, and a line of dead white locusts ran within 6 feet of the water's edge.

After leaving the lake, our course of 30°–40° took us across stony desolate country with a line of sandhills edging the sky, where was the sea, and isolated sandhills on our other hand. Thus for three days we made slow progress because of winter rains, which though light must thus affect us, having regard to our camels, prone to fatal splits in slippery weather. There was no firewood and so no camp fires, but cheer came from the contemplation of Doha, the capital of Qatar and my goal that lay but a day or two distant. It was a happy moment when, topping a rise in the plain, I saw before me the sea—the Persian Gulf, a shaikhly fort on its verge, with the promise, after desert diet, of hospitality—incomparable Arab hospitality. My journey was at an end. It had lain through the midmost heart of the virgin Rub' al Khali.

APPENDIX I

REGIONAL SANDS AND WATERHOLES OF THE RUB' AL KHALI

Sand Region and Waterholes	*Average depth in fathoms*	*Location*	*Length and breadth in days' marches*	*General direction*
I. EASTERN SAND REGIONS				
Al Hamra Zuraytan, Zaharani, Abu Ghar, Halib	4–5	Middle of eastern edge of sands: long. 55°: lat. 23°	3×3	—
Ghasaiwara Sweet water: fall of W. Aswad	½	South of Al Hamra; long. 55°: lat. 22°	2×1	N.—S.
Ghafa One brackish water-hole Khor Naqa	—	South of Ghasaiwara; long. 55°: lat. 21°	3×2	N.—S.
Ghanim Much water in West Khasfa, Ablutan, Bughara, Lahus Mansa, Abu Dhur, Dhirib, Tuwaifal	Varying between ½–3, but average 1	South-eastern corner of sands: long. 54°: lat. 20°	4×2	NE.—SW.
Batin Brackish Khiran many holes	1–2	Due south of Liwa and west of Al Hamra; long. 54°: lat. 23°	4×1	E.—W.
'Uruq al Maraikha 'Uruq Ash Shaiba 'Uruq Bin Tamaisha 'Uruq al Mijora None	—	Due south of Batin heavy dune country running north and south dividing habitable sands of centre from those of eastern borderlands; long. 54°: lat. 23°–20°	—	N.—S.
Sabkhat Mijora Umm Sahud	5	West of Ghanim; long. 54°: lat. 20°	2×1	E.—W.
II. CENTRAL SAND REGIONS				
Qidan Abu Qutub, Al Khubba (sweet), Garaini, Khor Tuwairish, Khor Bin Ham, Qara, Bil Hanna, Umm al 'Amad, Abu Ruwawil	4–5–6	South-west of Qidan; long. 53°: lat. 22°	5×3	NE.—SW.
Al Hamra No sweet water	—	South of Qidan; long. 53°: lat. 21° 30′	4×2	NNE.—SSW.
Hibak Plentiful but brackish —Haraim, Zaghain, Gardhum, Khor Jarub, Khor Saif, Manthur, Khor Shiban Khor Saba'in, Bu Istam,	2–3	South of Hamra; long. 53°: lat. 20°–21°	5×2	NNE.—SSW.

Khor 'Tar'uza, Khor Bin Tamaisha				
Suwahib Plentiful but generally extremely brackish (in parts Khiran, undrinkable by man or camel)	Generally ½–1 *fathoms*	West of Hibak; long. 51°–52°: lat. 19° 30′–21°	10×6 *marches*	NE.—SW.
(I) Hadh Buwah Bahat Faris(s) Bahat Salama, Bahat Jumal, Bahat Najran	1	long. 51°: lat. 20°	3×1	E.—W.
(II) Hadh Libda Hadh Ajman Khiran	2	long. 52°: lat. 20°	2×2	—
(III) Umm Malissa Western Sabkhat 'Ali Mahsin	—	long. 51°: lat. 20° 30′	2×1	E.—W.
Umm Malissa Eastern Fida, Sabkhat Njrah	—	long. 52°: lat. 20°–21°	3×1	N.—S.
(IV) Karsu'a Khiran	2–3	long. 52°: lat. 20° 30′	1½×1	E.—W.
(V) Wasa' Khiran	2–3	long. 52°: lat. 21°	1½×1½	—
Hadh Mazariq Hadh Nuwasif Hadh Munajjar Minjorat Mahayub, Minjorat Hadi	5	West of Karsu'a and Wasa'; long. 51°: lat. 21°	3×2	N.—S.
Hadh Abu Suraifa Khiran (Abu Suraifa)	½–2	West of Hamra; long. 52°: lat. 21°	4–5×2 5×1	N.—S.
Al Maharadh —	—	West of Qidan; long. 52°: lat. 22°		N.—S.
Hadh Mahaqiq Mijhut, Habaran, Bani Qadhai, Bu Mahaqiq, Abu Faris	2–3	West of Maharadh; long. 51° 30′: lat. 22°	4×1	N.—S.
Sanam Al 'Ubaila Umm al Hadid Umm Quraiyan, Safif, Turaiga, Farajja, Ibrahima, Fijafil, Umm al 'Amad, Asaila, 'Auda, Duwairis, Umm Raqa, Khalak, Al Hirra, Uwaiya, Banaiyan (Western waterholes of exceptional depth are called Tuwal), Bir Fadhil is said to be in Murbakh al Faris to West.	10–12	long. 51°: lat. 21°–23°	6–7×4	N.—S.
III. SOUTHERN SAND REGIONS				
Ramlat Mugshin Ramlat al 'Aradh Umm Dharta	—	The edging sands of south taking names from Wadis of same	1–2 days' depth	E.—W.

Fasad Mitan Shu'ait Dune country and well-less		name that fall into them (except Umm Dharta, where sands emit wheezing noise when walked upon); between long. 52°–55°: lat. 18° 30′–19° 30′		
'Uruq Adh Raqa'at, Raqa'a Ash Shamaliya, Raqa'a al Janubiya	2–3 *fathoms*	South of Hibak, north of Fasad; long. 53°: lat. 19°	4×4 *marches*	—
'Uruq al Miniyur	—	West of Raqa'at, north-west of Mitan; long. 52°: lat. 19°	2×2	—
'Uruq adh Dhahiya Khor Dhahiya, Bi Dhiyab, Bin Hamuda	— 2	North-west of Shu'ait; long. 51° 30′: lat. 19° Edging sands south-west of 'Uruq Adh Dhahiya; long. 51°: lat. 18° 30′	2×2 3×3	—
Kharkhir Kharkhir				
Umm Gharib	—	Edging sands west of Kharkhir; long. 50°: lat. 18°	2×2	
Ga'amiyat Said to be waterless	—	West of Umm Gharib; long. 49°–50°: lat. 18°–19°	8×5	NE.—SW.
Dakaka Bil Ashush, Sabla, Mashruma, Bil Afen, Turaiwa (15), Zuwayra, Shanna (11), Khudhifiya (6), Bir Hadi, Al Harsha, Wughawak, Bin Waraiqa, Umm Dasis, Tuwaiyal, Al Bahaisin, Ga'ada Mifatih, Khor Shiban, Abu Madaiyin, Ga'aimi Sigani, Gham Ghim	Eastern wells, 3; western, 15	Central southern sands just within edging sand dune country; long. 50° 30′–52° 30′: lat. 18° 30′–20°	7×3	WSW.—ENE.
IV. NORTHERN SAND REGIONS				
Mijan, Sabkhat Matti, Dhafra, Liwa, Qufa, Taff, Bainuna, Khatam, Jafura		As shown already on Hunter's map (ta Jafura)		
Zibda and Sha'ala	15			
Mijan	2			
Bainuna	4–6			
Jiban Bir Azila, Mabak, Khor al 'Awamir, Khor al 'Abd, Bil Ikirish, Bijran, Qadah, Wutait, Wusiya, Khuwaitima, Umm al Jira, Dhibi, Kharit, Minaiyif, Uqda, Suraiya, 'Al Izba, Haluwain (the	2–2½	Between Jafura and Mijan, south of Qatar peninsula; long. 51° E.: lat. 23°–25°	6×2	N.—S.

shallow waterholes of Eastern Jiban are called Aqal)				
Jaub				
Bir Aziz, Hugsha, Al Atsa, Nadgan, Umm Dharib, Al Bahath, Latit, Umm Maithala	5–11–17 *fathoms*	South-west of Jafura, north and west of Sanam from Jabrin to Banaiyan; long. 48° 30′ –51°: lat. 23°	5 × 3 *marches*	E.—W.
V. WESTERN SAND REGIONS (reported to be well-less)				
Jaddat al Juwaifa (not sand)	—	South of Jaub, west of Sanam; long. 50°: lat. 22° 30′	—	E.—W.
Hibaka	—	South-west of Sanam; long. 50°: lat. 21° 30′	3 × ½	NW.—SE.
Bani Zainan	—	South of Hibaka; long. 50°: lat. 21°	—	N.—S.
Abu Bahr (not sand)	—	South of Jabrin; long. 48° 30′: lat. 22°	5 × 1	N.—S.
Kursha al Ba'ir	—	West of Bani Zainan; long. 49°: lat. 21°	7 × 5	E.—W.
Shuwaikila (North)	—	South of Kursha al Ba'ir, north-east of Huwaiya; long. 49° 30′: lat. 20°	3 × 1	NNE.—SSW.
Huwaiya	—	North-west of Ga'amiyat; long. 49°: lat. 19°	5 × 2	NNE.—SSW.
Shuwaikila (South)	—	South-west of Huwaiya; long. 48°: lat. 18° 30′	4 × 1	NNE.—SSW.
Suman	—	South and west of Jabrin; long. 48° 30′: lat. 22° 30′	—	N.—S.
Haraisan	—	West of Suman; long. 48°: lat. 22° 30′	—	N.—S.
As Sahama (not sand)	—	West of Kursha al Ba'ir; long. 48°: lat. 21°	7 × 1	NE.—SW.
Uwairiq		West of Sahama; long. 47° 30′: lat. 21°	4–5 × 2½	NE.—SW.
Raida (not sand)		South of Haraisan and north-west of Uwairiq; long. 47° 30′: lat. 21°	10 × 1½	NE.—SW.
Other sands reported to West of these—				
N.W. REGION OF SANDS				
Idhawat al Faris, Rumaaila, Agonis				
S.W. REGION OF SANDS				
Bani Ma'aradh, 'Uruq al Jilida, Subaitain, Raiyan, Wudai'a, 'Uruq Abu Da'ar, Al 'Aradh, 'Uruq Az Zaza				

APPENDIX II

NOTES ON THE NATURAL HISTORY COLLECTIONS by members of the Staff of the British Museum (Natural History).

These notes are made after a first examination of the specimens. Further investigation will be required before it can be decided how many new species there are in the collection, but probably some twenty or more, including a fox, a snake, and various insects, will have to be described.

A. MAMMALS. By Captain J. G. Dollman, B.A.

Taphozous nudiventris Cretzschmar (the Naked-Bellied Tomb Bat). 'Ain, 1500 feet. Collected 8 Nov. 1930.

The genus *Taphozous* is found over a considerable part of Africa (except the north-western portion), Southern Asia and the East Indies eastward to Australia, New Guinea, and the Philippine Islands. This species, together with the Babylonian form (*T. babylonicus*), has been placed by some authorities in a genus distinct from *Taphozous* called *Liponycteris*. *Taphozous nudiventris* extends across tropical Africa from Nigeria to the Sudan and Tanganyika Territory and spreads eastwards into Arabia.

Hyaena hyaena L. (the Striped Hyaena). 'Ain, Qara Mts., 1500 feet. Mairbon, 2800 feet. Collected Nov. 1930.

Two of these specimens are males and the other one a female. With the latter specimen are two foetuses which show to advantage the marking of the coat in this species. These Striped Hyaenas may eventually prove to differ from Asiatic and African specimens of *Hyaena hyaena*. The species is one of several carnivores common to Africa and Asia: its range extending throughout northern and eastern Africa through Syria and Arabia to Asia Minor and India. In Africa a number of different races have been distinguished, but they are all very alike and doubtfully distinct.

Canis pallipes Sykes (Indian Wolf). 'Ain, Qara Mts., 2500 feet. 9 Nov. 1930.

This specimen represents the western limit of the species.

Vulpes vulpes arabica Thos. (Arabian Fox). 'Ain, Qara Mts., 1500 feet. Nov. 7. Khiyut, 1750 feet. Nov. 12. Jurbaib, 30 feet. Nov. 18. Khor Salala, sea-level. Nov. 24.

These specimens all appear to be rather blacker on the ventral surface than the typical *Vulpes vulpes arabica*. The type of this race comes from Muscat, and the Museum collection possesses a series of specimens from various localities in Arabia as well as specimens from Persia and Egypt which probably belong to the Arabian race.

Fennecus sp. (Arabian Fennec Fox). One specimen.

This Fennec would appear to represent an Arabian race of the Egyptian Fennec which is found in North and North-East Africa. The Museum possesses one specimen from the desert of Al Kuwait in Arabia, which may be useful to compare with the present specimen when the time comes for working out these interesting foxes.

Mellivora ratel Sparrm. (Ratel). Sha'ab Fuzul, 250 feet. Nov. 18.

The Ratel is found over a very great part of Africa south of the Sahara and extends eastward into India. Very little variation in colour or size can be found between the African and Indian forms, and at the most they would appear to be merely geographical races.

Gerbillus arduus Chees. and Hint. (Arabian Gerbil). Three specimens.

The sub-family Gerbillinae contains the African and Asiatic Gerbils in which the incisor teeth are grooved and the hind-feet elongated. The Common Gerbils

of Africa are placed in two genera, *Taterona* and *Gerbillus*, the species of which are usually bright buff or sandy in colour above and pure white below.

Arvicanthis testicularis Sund. (Field Rat). One specimen.

The common Field Rat of Africa, *Arvicanthis testicularis*, is divisible into a very large number of local races, and possibly, when more material is available for examination, it will be found that the Arabian Field Rat is a pale race of the typical African Field Rat.

Lepus omanensis cheesmani Thos. (Cheesman's Arabian Hare). Yadil, 1000 feet. Dec. 22. Ramlat Urba, 900 feet. Dec. 25. Shanna, 1000 feet. Jan. 5.

These four specimens would appear to represent the hare that was recently named after Major R. E. Cheesman.

Gazella muscatensis Brooke (Muscat Gazelle). 'Ain al Rizat, 220 feet. Oct. 30. Jurbaib, 50 feet. Nov. 24.

This gazelle is closely allied to the Arabian Gazelle, from which it is distinguished by its rather smaller dimensions; the tips of the horns are usually turned sharply inward instead of forward.

Procavia syriaca jayakari Thos. (Arabian Cony). Ilha'az, 1800 feet. Nov. 12. Deriyot, 1750 feet. Nov. 13.

This race was described by the late Oldfield Thomas from Dhufar in Southern Arabia. It is a close relation of the typical *Procavia syriaca syriaca* originally described by Schreber as "*Hyrax syriaca*" in 1784.

B. REPTILES AND AMPHIBIANS. By H. W. Parker, B.A.

The reptiles and amphibians collected by Mr. Bertram Thomas are sharply divisible into two groups, corresponding with the two contrasting climatic and vegetational zones which he visited. Not a single species was found to be common to the two regions and only one genus, *Agama*, has a species in both. The conditions of life in the arid Rub' al Khali demand a degree of specialization not required for life in the forested Qara Mountains and Dhufar littoral, but this does not appear to have been the sole factor at work in producing such marked differentiation. The paucity of snakes in the desert (where only 3 species were found as compared with 8 in Dhufar) and the relative abundance of lizards (12 species compared with 5 in Dhufar) may reflect the adaptability of the two groups, but meteorological conditions can scarcely be invoked to account for the absence from Dhufar of such a plastic family as the Lacertidae. A critical examination of the lists given below shows that the Dhufar fauna has a strong Ethiopian element, whereas that of the desert has a decided Palaearctic facies; genera such as *Psammophis*, *Atractaspis*, and *Bitis* are essentially Ethiopian, but *Alsophylax*, *Phrynocephalus*, *Acanthodactylus*, and *Malpolon* are scarcely known outside the Palaearctic region. It is difficult to avoid the suggestion that in Dhufar there is a relic of the former population of Arabia, persisting from the epoch when the Indian and Ethiopian regions were faunistically one; desiccation destroyed this primitive fauna over a large area, and the dry region was subsequently re-populated from the north.

The species collected, and the approximate geographical ranges of each are:

QARA MOUNTAINS AND DHUFAR LITTORAL

Lizards: Geckoes. 1. *Pristurus rupestris* Blanf. Shahari: Ichera, Ijeroh. Arabia, and Socotra to Sind. 2. *Pristurus carteri* sub sp. Shahari: Budh. This species ranges from Aden to Muscat, but three geographical races are recognizable, one in the north-east, another in the south-west, and the third, hitherto undescribed, from the southern slopes of the Qara Mountains.

Agamas. 3. *Agama sinaita* Heyden. Shahari: Zedakhait, Sidahait. From Libya and the Sudan to Syria and Muscat.

Northern sands: near Banaiyan

Northern sands: dispersing in search of food

Halt for prayer: Central sands, Sanam

Lake Sabkhat al 'Amra: rock-salt in foreground

Na'aijah: first settlement on emerging from desert

Doha: the end of the journey

Skinks. 4. *Chalcides ocellatus ocellatus* (Forsk.). Shahari: Gemsh. Algeria to Egypt, Syria, Cyprus, Crete, Greece, Arabia, Persia, and Baluchistan.

Chamaeleon. 5. *Chamaeleon calcarifer* Peters. Shahari: Shahabel. Aden to Muscat.

Snakes: Colubrids (Harmless). 6. *Coluber rhodorhachis* (Jan). Shahari: Difen, Ojem, or Shalthum. Egypt to Somaliland, Arabia, Syria, Persia, Baluchistan, Transcaspia, and North-West India. 7. *Coluber* sp. Shahari: Shalthum. This species does not appear to have been described; it is allied to *C. variabilis* of the Aden hinterland and *C. somalicus*. 8. *Spalerosophis diadema* (Schlegel). Shahari: Fe'e de'e. Africa north of the Sahara to Turkistan and North-West India.

Colubrids (slightly venomous). 9. *Psammophis schokari* (Forsk.). Shahari: Ishor, Inshor. Africa north of the Sahara to Persia, Afghanistan, and North-West India.

Cobras (venomous). 10. *Naja haje* (Linn.). Egyptian Cobra. Shahari: Haut; juveniles Difen or Ojem. South-East Arabia to the Transvaal and Zululand; westwards, north of the Sahara, to Morocco; the present is the most northerly record. 11. *Atractaspis andersoni* Boulenger. Shahari: Disos. Hitherto known only from the extreme south of Arabia.

Vipers (venomous). 12. *Echis carinatus* (Schneid). Shahari: Ojem. Africa north of the Equator to Transcaspia, and India. 13. *Bitis arietans* (Merrem), Puff-adder. Shahari: Dololat. Africa, except the Rain Forest regions, and South Arabia; the present is the most northerly record.

Amphibians: Frogs and Toads. 14. *Bufo* sp. Shahari: Aqaqet. The status of this toad is uncertain, but it appears to be allied to species recorded from the Aden hinterland and Somaliland.

RUB' AL KHALI

Lizards: Geckoes. 1. *Alsophylax blanfordii* (Strauch). Arabic: Nagas Milh. Alaghaybis, or Dhatur. Egypt and South Arabia. 2. *Ceramodactylus major* Parker. Arabic: Dhatur. Hitherto known from only two specimens, both collected by Mr. Bertram Thomas on his previous journey to the Rub' al Khali.

Agamids. 3. *Phrynocephalus arabicus* Anderson. Arabic: Abu Tahay or Bu Tahaihi. Hadhramaut to the Persian Gulf. 4. *Phrynocephalus maculatus* Anderson. Arabic: Fakhakh, Bu Radhaima or Sharaihi. Persia, Baluchistan, and East Arabia as far south as Dhufar. 5. *Agama jayakari* Anderson. Arabic: Fakhakh. Muscat to the Dhufar hinterland, northwards to El Qatar. 6. *Uromastix thomasi* Parker. Arabic: Bu Kurdifat or Bu Qursh. Previously known from two specimens, both collected by Mr. Thomas.

Monitors. 7. *Varanus griseus* (Dand.). Grey Monitor. Arabic: Wural or Ruwal. Morocco to the Sudan, northwards to the Caspian and North-West India.

Lacertids. 8. *Acanthodactylus cantoris* Gunther. Arabic: Asawada or Sauwedda. The distribution of this species, as hitherto known, was discontinuous, no specimens having been recorded between Persia and the Aden-Wadi Hadhramaut district of South Arabia. The specimens in the present collection bridge the distributional gap, but do not link the northern and southern races in morphological characters. 9. *Acanthodactylus scutellatus* (Audouin). Arabic: Dhubdhuba. Africa, north of the Sahara, from Cape Verde to the Sudan, Palestine and 'Iraq. 10. *Eremias brevirostris* (Blanf.). Arabic: Nagas Milh. Punjab, Baluchistan, Persia, 'Iraq, Syria; not previously known so far south. 11. *Eremias adramitana* Boulenger. Arabic: Suwayda. Hitherto known only from the Hadhramaut.

Skinks. 12. *Scincus mitranus* Anderson. Arabic: Damusa or Bihalaklak. Sind and South-East Arabia.
Snakes: Boas. 13. *Eryx jayakari* Boulenger. Arabic: Difen. Muscat and Yemen.
Colubrids. 14. *Malpolon moilensis* (Reuss). Arabic: Zaraq. Algeria to the Sudan, northwards to 'Iraq and South Persia.
Vipers. 15. *Cerastes cornutus* (Linn.). Egyptian Horned-viper. Arabic: Kabsh (male). Algeria to the Sudan, Arabia, 'Iraq.

C. LOCUSTS, GRASSHOPPERS, MANTIDS, etc. By B. P. Uvarov.

The collection of *Orthoptera* is valuable because it contains specimens of several Arabian species very poorly, or not at all, represented in the Museum. At least two of the Orthoptera are new, viz. No. 358, *Conocephalus* sp. n., and No. 502, a Mantid which certainly belongs to a new species and probably to a new genus.

Cockroaches
Periplaneta australasiae L.
Blatella mellea Kr. New to Brit. Mus.
Mantids
Eremiaphila sp.
Tarachodes sp. An essentially African genus.
Genus nov. ?
Crickets
Liogryllus bimaculatus Deg.
Grasshoppers and Locusts
Acridella 2 spp.
Aiolopus thalassimus F.
Morphacris fasciata sulcata Thnbg.
Pycnodictya dentata Kr. New to Brit. Mus.
Sphingonotus balteatus Serv. sbsp. n.
Leptoscirtus sp. (probably new).
Euprepocnemis sp.
Cataloipus sp. An essentially African genus.
Acrotylus insubricus Scop.
,, *longipes* Charp.
Catantops saucius Burm. An African species.
Acorypha sp.
Cyrtacanthacris tatarica Q.
Schistocerca gregaria Forsk. The Desert Locust.

D. DRAGONFLIES. By Miss C. Longfield.

Of sixty-two specimens received, the following nine species have been determined: 6 *Libellulinae*, 1 *Coenagrionine*, 1 *Aeschnine*, which are all common African species, and one new species of *Urothemis*.

1. *Pseudomacromia torrida* Kirby. 3 males, 1 female. Milwah Al Aud. Oct. 30. 'Ain al Rizat. Oct. 31. Found in South, West, and East Africa. The dimensions of these four specimens run small, and the wings are exceptionally deeply saffroned in both sexes.
2. *Pantala flavescens* Fabr. 1 male, 1 female. Sahalnot. Nov. 4. Common nearly all over the world.
3. *Trithemis annulata* Beauv. 12 males, 1 female. Milwah al Aud. Oct. 30. 'Ain al Rizat. Oct. 31. Sahalnot. Nov. 4. Khiyut. Nov. 11. Common in North and East Africa and Arabia.
4. *Crocothemis erythraea* Brulle. 10 males, 5 females. Sahalnot. Nov. 4. 'Ain

(Qara Mts.). Nov. 9. Khiyunt. Nov. 11. Has a wide range over South Europe, all Africa, and parts of Asia.

5. *Orthetrum chrysostigma* Burm. 13 males, 8 females. 'Ain al Rizat. Nov. 1. Sahalnot. Nov. 4. "Ain." Nov. 5. Khiyut. Nov. 10, Nov. 11, Nov. 13. Milwah al Aud. Oct. 30. In. Nov. 14. Has a wide range over South Europe and Africa.
6. *Diplacodes lefebvrei* Ramb. 1 male. Sahalnot. Nov. 4. Has a wide range over Africa to Arabia.
7. *Hemianax ephippiger* Burm. 2 males. Sahalnot. Nov. 4. Farajja (Sanam). Jan. 21. Found in North and East Africa, Arabia, Persia, and North India.
8. *Ceriagrion glabrum* Burm. 3 males, 2 females. Khiyut. Nov. 11, Nov. 13. Has a wide range over North, South, East, and West Africa. The wings of these five Arabian specimens are extra deeply saffroned.
9. *Urothemis* sp. n. 1 male. 'Ain al Rizat. Oct. 31.

E. BUGS. By W. E. China, M.A.

The collection contains eleven bugs representing ten species and genera. Of these species three are apparently new, three are of wide distribution in the Eremian sub-region, one is recorded only from Turcomania, two are of Indian origin, and one is widely distributed in the Ethiopian and Oriental Regions and the Mediterranean sub-region. Two of the Eremian species have previously been recorded from Arabia, and one extends into the Mediterranean sub-region.

On the whole, the collection corroborates the belief that Arabia faunistically forms part of the great Eremian sub-region which extends from Senegal and North Nigeria in the west, across the Sahara to the Sudan, across Arabia and Persia to the Punjab and Turkistan.

1. *Macroscytus brunneus* F. Fuzah, 1350 feet. 14 Nov. Local name, Adhayrite. Widely distributed in the Mediterranean, Ethiopian, and Oriental Regions.
2. *Cydnus* sp. nov. near *pilosulus*. Fuzah, 1350 feet. Nov. 14. Local name, Adhayrite.
3. *Amaurocoris orbicularis* Jak. Hadh al Mazariq, 570 feet. Jan. 17. Recorded only from Turcomania.
4. *Chroantha ornatula* H. S. Bahat al Jamal, 550 feet. Jan. 15. Hadh al Mazariq, 570 feet. Jan. 17. Recorded from Spain, Dalmatia, Sicily, Greece, Algeria, Tunisia, Egypt, Syria, Persia, Turcomania, and Arabia.
5. *Adria parvula* Dall. Fuzah, 1350 feet. Nov. 14. Local name, Adhayrite. Recorded from North India and South Persia.
6. *Carbula insocia* Walk. Fuzah, 1350 feet. Nov. 14. Local name, Adhayrite. Recorded from India both North and South.
7. *Centrocoris* sp. nov. near *degener* Put. Suwahib, 600 feet. Jan. 14. Local name, Tassaiyah.
8. *Cosmopleurus fulvipes* Dall. Hamr al Ain Abn Genin. Dec 21. Siddat al Harsha, 900 feet. Recorded from Algerian Sahara, Egypt, Sudan, Nubia, and Persia. Recorded food plant: *Calotropus procera*.
9. *Dieuches* sp. nov. 'Ain al Rizat, 250 feet. Oct. 31. Local name, Digadig. There are in the British Museum collection specimens from Mesopotamia.
10. *Laccotrephes fabricii* Stal. 'Ain al Rizat. Oct. 31. Local name, Sinortami (water cat). Recorded from Arabia, Suez, Sudan, Abyssinia, and Senegal. Also doubtfully from East Africa, South Africa, and India.

F. BUTTERFLIES. By Captain N. D. Riley.

Fifteen species of butterfly were obtained, two of which are new and belong to the genus *Charaxes*. The species are strongly African in their affinities, as the following rough analysis will show:

Species occurring throughout Africa (1) and to Australia, are: *Danais chrysippus*, *Precis orithya;* (2) and as far as India, including Ceylon (and Burma in one case), are: *Teracolus calais*, *Teracolus danae*, *Azanus jesous;* (3) but not found east of Arabia, are: *Charaxes varanes* (of which a new ssp. was obtained), *Leuceronia buquetii*, *Herpaenia eriphia*, *Sarangesa vliminata*, *Myrina silenus*.

Species found only in Northern Africa (south of the Sahara), Sudan, Abyssinia, Somaliland, and drier parts of Kenya Colony, are: *Charaxes hansali* (a new subspecies), *Teracolus evarne*.

Mediterranean species are: *Tarucus theophrastus* (which also reaches India), *Apharitis myrmecophila* (known only from Tunisia and Trans-Jordan).

Almost cosmopolitan is *Pyrameis cardui* (The Painted Lady).

The absence of certain species taken by Cheesman at Hufuf and of others known to occur in the Aden district is striking, but further collecting will probably bring some of them to light. Cheesman's most remarkable find at Hufuf consisted of the two essentially palaearctic species, *Papilio machaon* (the Swallowtail), and *Colias croceus* (the Clouded Yellow), neither of which was obtained by Mr. Bertram Thomas. Several other species, notably the *Citrus*-frequenting Swallowtail *Papilio demoleus*, which is not uncommon at Muscat, might reasonably have been expected.

On the other hand, the occurrence in some numbers of the two species of *Charaxes* and of the brilliant blue *Myrina silenus* is very unexpected. All three are truly African insects, none having ever been recorded from any part of Arabia hitherto. Of none of the species of butterfly obtained can it be said that it is essentially oriental. The two small blue butterflies *Taracus theophrastus* and *Apharitis myrmecophila* provide the most northern element.

1. *Teracolus calais*. One very much damaged female. Occurs throughout Africa; Aden; Bombay.
2. *Teracolus danae*. Indicates clearly that the African "*T. eupompe*" and the Indian "*T. danae*" are but races of one species. The racial characters are best seen in the female, of which sex there is however one specimen only, which is in poor condition.
3. *Teracolus evarne* (25 specimens). Not hitherto recorded east of Aden. Very common in northern drier parts of Africa.
4. *Herpaenia eriphia*. Common throughout Africa. First record from Arabia.
5. *Leuceronia buquetii*. Recorded from all parts of Africa, and from Aden.
6. *Danaida chrysippus* (16 specimens). Throughout Africa and the East as far as Australia. Of the sixteen specimens, only two were var. *dorippus*, which is often the commoner form in arid regions.
7. *Pyrameis cardui* (The Painted Lady). Almost cosmopolitan.
8. *Precis orithya*. Throughout Africa and tropical Asia to Australia. This species and *Teracolus danae* afford the only cases in which the Qara Mountains race may be more closely related to the Oriental than to the African race; but in both cases the material is somewhat damaged, and, in any event, it is impossible to form a definite opinion before the specimens have been mounted. No approach to sub-species *cheesmani* of Hufuf oasis.
9. *Charaxes hansali* (new sub-species). A rare species known only from northern Kenya Colony, Sudan, Abyssinia, and Somaliland. Not recorded from Aden or any other part of Arabia.
10. *Charaxes varanes* (new sub-species—or may be a new species). *Ch. varanes* occurs throughout Africa, south of the Sahara, but has not certainly been recorded from any locality nearer Arabia than Kenya Colony. The new form has certain features in common with the closely related *Ch. saperanus* of the Comoro Islands, and *Ch. balfouri* of Sokotra.

11. *Myrina silenus*. Occurs throughout Africa south of the Sahara, including Abyssinia and Somaliland. No previous record from any part of Arabia; not even known from Aden.

12. *Apharitis myrmecophila*. This species was only recently discovered in Tunisia, the larva living in ants' nests or in close association with ants. Subsequently it was met with in Trans-Jordan. This is only the third known occurrence of the species.

13. *Tarucus theophrastus*. Not known from Africa south of the Sahara. Occurs in Spain, North Africa, Egypt, Palestine, Syria, Abyssinia, Somaliland, Aden, Mesopotamia, and eastwards to North-West India.

14. *Azanus jesous*. Throughout Africa, Syria, Aden, to Ceylon and Burma.

15. *Sarangesa eliminata*. A common African species, particularly in the more arid regions. Common at Aden.

G. MOTHS. By W. H. T. Tams.

The Moths, which are not so numerous as the butterflies, include:

Euproctis sp. (near *E. pygmaea*, probably new).
Bryophilopsis tarachoides Mab.
Arcyophora longivalvis Guen.
Achaea catella Guen. A common and widely distributed species.
Pandesma anysa Guen.
Anumeta cestis Mab.
Anumeta hilgerti Roths (new sub-species).
Anumeta sp. (probably new).
Somatina virginalis Prout, or a new race of this species.
Cossus cheesmani Tams. (Discovered by Cheesman on journey to Hufuf.)
Bombycopsis hyatti Tams. (Recently discovered in Somaliland.)
Zygaena sp. (Probably new, of very palaearctic appearance.)
Ommatopteryx ocellea Haw. A common and widely distributed species, which even occurs in England.
Bradina admixtalis Walker.

Like the butterflies, the Moths are more closely allied to the African than to the Oriental fauna.

H. BEETLES. By K. G. Blair, B.SC.

There were in all fifty-one specimens (twenty-three species), viz.:

Buprestids: *Capnodis excisa* Mén., an interesting metallic variety (? new), and three species of *Psiloptera*.
Dung-beetles: two common species, including *Scarabaeus sacer*.
Cockchafers: *Pachydema* sp. Apparently new.
Rose-beetles: *Pachnoda spreta* (1). New to Brit. Mus.
Tenebrionids: the thirty-two specimens are representative of thirteen species, and include a species of *Adesmia* (*Oteroscelis*) new to the Brit. Mus. and probably undescribed; *Leucolaephus* sp., new to the Brit. Mus.; and two species of *Pimelia*, new to the Brit. Mus.
Weevils: *Cleonus* sp. One specimen.
Longicorns: *Batocera rubus* L., an Oriental species, probably introduced; three specimens.

K. BEES, WASPS, etc. The bees have been identified by Mr. R. B. Benson, the wasps by Mr. R. E. Turner, and the ants by Mr. H. Donisthorpe. The report on this Order has been compiled by Dr. Hugh Scott.

Fourteen species of *Hymenoptera* were collected, and it has been possible to

name ten (the remaining four can at present only be referred to their genera). The most noticeable fact is that their affinities are as much with Africa as with the Orient, or even more so. Four species are common to the northern part of Africa and Southern or South-Western Asia; one species, a common wasp (*Polistes hebraeus*), is a widely spread Oriental form not occurring in Africa; and one species has previously been taken only in Southern Arabia. Apart from these, no Asiatic element is apparent. The remaining named species comprise one that occurs in the Mediterranean Region and all over Africa; one that is widely spread in the northern and central parts of that continent; and two that are widely distributed in tropical Africa. The case of one of these last is very remarkable, namely the ant *Messor barbarus* sub-species *galla;* the species is widely distributed in southern Europe, Africa, and parts of Asia as well, but the sub-species *galla* has hitherto been known only from Africa (where it occurs in Abyssinia, East Africa, Somaliland, the Sudan, and Senegambia), and the addition of the Qara Mountains to its known range is of considerable interest.

Bees: *Xylocopa aestuans* L. Qara Mountains: Fuzah, 120 feet, Nov. 19; Khiyut, 1750 feet, Nov. 12–13; 'Ain al Rizat, 250 feet, Oct. 31; Milwah al Aud, 220 feet, Oct. 30. Dhufar: Salala, sea-level, Nov 25. Northern Africa, Sudan, etc., West and South Asia.

Xylocopa fenestrata F. Qara Mountains: Khiyut, 1750 feet, Nov. 13; Fuzah, 1350 feet, Nov. 15; 'Ain al Rizat, 250 feet, Nov. 1. Northern Africa, Southern Arabia, India, etc.

Anthophora sp., not in the British Museum Collection. Rub' al Khali: Shanna, 1000 feet, Jan. 5.

Wasps: *Polistes hebraeus* F. Dhufar: Salala, sea-level, Nov. 25. Widely distributed in the Oriental Region and Pacific.

Cyphononyx bretoni Guér. Qara Mountains: 'Ain Qara, 1500 feet, Nov. 8. North and Central Africa, including Mediterranean and Cape Verde Is.

Hemipepsis heros Guér. Qara Mountains: Fuzah, 1350 feet, Nov. 14. Tropical Africa.

Trogaspidea sp., not in the British Museum, possibly new. Qara Mountains: 'Ain al Rizat, 250 feet, Oct. 30 and Nov. 2.

Solitary fossorial wasps: *Sceliphron spirifex* L. Qara Mountains: Fuzah, 1350 feet, Nov. 14–15; 'Ain Qara, 1500 feet, Nov. 9 and 16. Mediterranean and Ethiopian Regions.

Tachysphex aemulus Kohl, *var.* Qara Mountains: 'Ain al Rizat, 250 feet, Nov. 2. Southern Arabia ('Abd el Kuri and Ras Fartak, 1899, Expedition of the Vienna Academy of Sciences).

Sphex heydenii Dahlb. Qara Mountains: Milwah al Aud, 220 feet, Oct. 30. Mediterranean and West Asia.

Bembex dahlbomi Handl. *var.* Rub' al Khali: Banaiyan, 300 feet, Jan. 28. North Africa and South-West Asia.

Ants: *Messor barbarus* L. sub-species *galla* Em. Qara Mountains: Khiyut, 1750 feet, Nov. 11. Three soldiers. Abyssinia, Somaliland, Sudan, East Africa, and Senegambia.

Camponotus (*Tanaemyrmex*) *compressus* L. sub-sp. *thoracicus* L. Qara Mountains: Milwah al Aud, 220 feet, Oct. 30. One soldier. Deserts and oases of Algeria and Tunisia.

Crematogaster (*Sphaerocrema*) sp. (indeterminable from female sex alone). Rub' al Khali: Bahat al Jamal, 500 feet, Jan. 15. (Two queens, one winged, with the venation of the fore-wings abnormal, the other dealated.)

L. TWO-WINGED FLIES. By Dr. F. W. Edwards, M.A., and Miss D. Aubertin, M.SC.

The Diptera include very few species, but among them is the mosquito *Anopheles mauritianus*, taken in Jurbaib Qara littoral, of which there is no previous Arabian record, although the species occurs in Egypt and South Palestine, and also throughout tropical Africa. The Bee-flies (*Bombyliidae*) include *Bombylius analis*, a common African species, also found in Palestine, and a species of *Exoprosopa* new to the Museum. Other flies of Ethiopian affinities are a species of *Promachus* (a robber-fly), *Eristalis taeniops* (a hover-fly), three species of blow-fly, and *Hippobosca maculata*, an ectoparasite of the camel.

M. SHELLS. By G. C. Robson, M.A.

The *Mollusca* obtained by Mr. Thomas at Farhud are represented by thirty-five specimens and thirteen species, all of which are marine. Forms like the *Potamides* and *Cardium* are probably euryhaline, *Potamides* being usually considered a brackish water or estuarine genus.

Retusa turrigera Melville.
Murex (*Chicoreus*) *anguliferus* Lamarck.
Drupa margariticola (Broderip).
Potamides cingulatus (Gmelin).
**Pirenella conica* (Blainville).
Cerithium moniliferum Kiener.
* „ *scabridum* Philippi.
Glycimeris pectunculus (L.) var.
Cardium (*Trachycardium*) *rubicundum* Reeve.
Asaphis deflorata (L.).
Psammotaea elongata (Lamarck).
Two *Lamellibranchs*, perhaps a *Paphia* and a *Chama*, indeterminable.

All the above species are living in the Indian Ocean at the present day, the two marked * extending also into the Mediterranean. The specimens of *G. pectunculus* differ somewhat in shape from any recent ones we have, but it is a variable species.

N. FOSSILS. By L. R. Cox, M.A.

The fossils collected by Mr. Bertram Thomas in his traverse of the Rub' al Khali, like those obtained on his previous expedition (see *G.J.*, 77, 1931, p. 31), are all from a white limestone of Middle Eocene age. They come partly from the southern part of the Rub' al Khali interior and partly from the low-lying plain beyond Misaimir, in the hinterland of Doha, on the Persian Gulf. The Eocene limestone thus seems to be the most widespread sedimentary formation in this part of Arabia. The following species are represented; all those identified specifically are forms discussed in a recent paper by myself on mollusca from the Eocene of India (*Trans. R. Soc. Edinb.*, vol. lvii, pt. 1, no. 2, 1931).

From the Rub' al Khali Interior: *Ostrea brongniarti* (Bronn), thick depressed left valve (near Ramlat Ubaila); *Lucina pharaonis* Bellardi, two internal casts (Kharaimat Fasad); *Hippochrenes* cf. *amplus* (Solander), internal cast (Kharaimat Fasad).

From the Plain beyond Misaimir, Doha hinterland: *Ampullospira* cf. *oweni* (d'Archiac and Haime), *Gisortia* sp., *Campanile* sp., all internal casts.

The above determinations confirm a preliminary report on the age of the fossils made by Dr. J. A. Douglas, palaeontological adviser to the Anglo-Persian Oil Co., Ltd.

O. METEORITE, ROCKS, AND MINERALS. By W. Campbell Smith, M.A.

By far the most interesting specimen in Mr. Bertram Thomas's geological collection is a stone picked up on the sand at Buwah, Suwahib, on 14 January 1931, which proves to be a meteorite. The stone is of irregular form with quite sharp angles measuring $9 \times 4\frac{1}{2} \times 4$ cm. and weighing before examination 241 grammes. It is coated with limonite glazed by the wind, and quartz grains are firmly cemented in little patches in the hollows on its surface. This limonite glaze completely disguised the true nature of the stone, and it was at first passed by as a fragment of "iron pan." Subsequent re-examination showed it to contain a high proportion of magnetic nickeliferous iron, and when a thin section was prepared for the microscope it showed the chondrules cemented by a metallic matrix typical of many stony meteorites. None of the original crust seems to be preserved, and the stone is probably an inner portion of a much larger meteorite burst into pieces in its passage through the atmosphere. A complete examination of this stone is necessary before it can be fully described, but it appears to be, in Brezinas's classification, a black spherical chondrite. Its density is 4·2.

The only other known meteorites from Arabia are the famous stone preserved as a sacred relic in the Ka'ba at Mecca, of which the history goes back beyond the seventh century, a grey bronzite-chondrite which fell at Et Tlahi in the Hejaz in 1910, and a meteoric iron found in 1863 at Nejd, of which two masses weighing 131 and 137 lb. were found in the Wadi Bani Khaled. These were said by the agent who sold them to have fallen during a thunderstorm, but it seems probable that they were not actually seen to fall.

The Hejaz meteorite was described by J. Couyat (*C.R. Acad. Sci.*, Paris, 1912, 155, 916). The Arabs who brought it him said it fell on a night in the spring of 1910 and that four pieces were found in an area about 15 km. across. One of them came from Et Tlahi, about 6 days' journey (by camel) from the coast at Doba (? Dhaba) in Madian (? Midian). The fragments of this meteorite in the British Museum are much lighter in colour than the Suwahib meteorite, and chondrules described by Couyat in the Hedjaz stone are much larger.

Gypsum was found at Hadaba Dhibi at 250 feet (No. 45, 30 January 1931) forming clear cleavage plates (selenite), and farther north as rounded fragments of pink alabaster at Lizba at sea-level (No. 48, 1 February 1931). At this locality it was associated with a fine-grained pink sandstone, a compact pale-pink limestone, and an apparently recent, cemented shell-sand. In a quite different form gypsum was found with the highly saline sand associated with the marine, recent shells from Farhud (see note on shells by Mr. G. C. Robson). Here the gypsum occurs in small crystals of approximately hexagonal outline and lenticular section, a habit which is unusual but is found in the gypsum deposited in some South African salt-pans at Uitenhage in Cape Province, and at Riverton near Kimberley. The peculiar habit is caused by a rounded development of the pyramid faces (111) so that the crystals are flattened parallel to the dome face (101). Curiously enough a similar form is developed by gypsum crystals in vesicles of some lavas at Aden.

Salt (Halite) was collected at Sabkhat al 'Amra. An analysis made in the Anglo-Persian Oil Company's laboratory gave 86·7 per cent. of sodium chloride and 9·25 per cent. of sodium sulphate. It is present in appreciable quantity in two sand samples from Sanam (Nos. 33 and 40), and in abundance with the gypsum in the shell-bearing sand at Farhud just mentioned.

Another mineral of some interest is aluminite, found at Turaiga Sanam (No. 39, 20 January 1931) in the form of flakes of irregular form resembling whitened fragments of bone.

With the fossils identified by Mr. L. R. Cox as Eocene from Kharaimat Fasad were found red flints and hollow chalcedonic concretions lined with quartz

crystals which when loose rattle about when the stone is shaken. They are almost certainly of the same kind as the quartz geodes described by G. E. Pilgrim (*Mem. Geol. Surv. of India*, 1908, vol. 34, pt. 4, p. 116) as occurring in great abundance in a soft white marl and in the limestones of Eocene age in the Bahrain Islands. These stones, known locally as *gilgil*, were not credited by the Arabs with any special powers, except that of absorbing warm milk if immersed in it.* It seems probable however that stones of this kind are one of the many varieties of Aetites, or Eagle-stone, mentioned by Pliny. The name *Aetites* seems to have been applied to various hollow concretions within which some loose stone rattled about. The lore of these eagle-stones is curious. The best kind were supposed to be found in the nests of some species of eagle and were believed in some way to help them to lay. For human beings they were regarded as a powerful charm assisting the birth of children, preserving children from harm, conferring sobriety, increasing riches, and bringing victory and popularity.

Other concretions found by Mr. Thomas at 1000 feet, 10 miles south-west of Shanna (Nos. 13–17, 4 January 1931) are calcareous sandstone concretions which bear a superficial resemblance to fossil bones. One of these is nearly 2 feet long and like a rib bone, another, remarkably symmetrical, 1½ feet across, bears some resemblance in outline to the pelvic girdle of some reptile. The concretions consist of quartz sand-grains cemented with calcite. With the bone-like large ones were others, small and spherical, or in odd shapes like Losspuppen or Fairy Stones.

The sand in the district from which the first Eocene fossils came is surprisingly rich in grains of limestone. Sand-dune gravel from 'Uruq Mitan, consisting of white and brown grains up to 3 mm. in diameter, consists entirely of limestone pebbles. A greenish sand noticed below the surface of red sand about Dhahiya 'Uruq consists mainly of minute grains of limestone, along with many other minerals, among which green glauconite is common. About Shanna were also found two pebbles of white quartz, one about 3 cm. in diameter. A similar sand is that from Shanna at 1000 feet, and from Gusman at 900 feet is a sample resembling the finer-grained portion of the sands of 'Uruq. Lighter in colour, but still containing abundant grains of pink-and-white limestone, are the sands from the southern Sanam border, Jadida, and Tarega. The larger grains in these sands, about 1 mm. in diameter, are well-rounded, and the majority are of quartz. The smaller grains, averaging 0·1 mm. in diameter, are subangular. No detailed analyses of the heavy minerals in these sands have yet been made.

Farther north in Sanam and Jaub the composition seems much the same, with the addition of grains of black rhyolite and other rocks similar to those which occur in the gravel plain in the Jaub area, north of Banaiyan.

The pebbles collected in northern Sanam consist of buff-coloured limestones with small dendritic markings, and showing etching and wind polish; quartz, pale yellows to the colour of carnelian; olive-green epidosite; black and very dark red rhyolite, somewhat vesicular; brick-red quartz-porphyry; and a rough flattened nodule of chalcedony.

These are similar to the pebbles collected by Major R. E. Cheesman from the gravel plain which he found between the limestone areas of Hufuf and Jabrin. The assemblage of pebbles is similar and some of the kinds are identical, for example, the buff-coloured limestone, the black rhyolite, and the epidosite, and yellow quartz. In that area the immediate source of the pebbles appeared to be a bed of conglomerate which lies below the gravel plain in the Jafura desert and

*One of these concretions, 7 cm. in diameter, did not absorb cold water, but it took up about 30 cc. when the water was gently heated up to about 90° C.

outcrops in the bed of the Wadi Sahba.* It is possible that the steep outcrops in sand noticed by Mr. Bertram Thomas at Banaiyan may be due to a similar formation.

P. ANALYSES OF WATER, SAND, AND SALT. By Dr. B. K. N. Wyllie.

The salinity of all the samples is many times (50 to 100 times) greater than that of normal river or lake waters. In every case the acid radicles determined exceed the bases; and some 2–4 gms./litre of sodium are presumably present—that is to say, the waters contain relatively large proportions of alkali sulphate and chloride, with subordinate amounts of alkaline earths (calcium and magnesium). One might perhaps guess that gypsum or gypseous strata underlie a good part of Mr. Thomas's route. To attempt a complete analysis of any of the water samples would have been impossible, because of the extremely small quantities available. The largest sample, No. 22, contained 250 c.cs., a quantity much too small for complete analysis.

Of the sand samples, two contained an appreciable quantity of sodium chloride, two a heavy trace, three a trace, and two none.

The salt sample consisted of sodium chloride, 86·7 per cent., sodium sulphate, 9·25 per cent., water, 4·2 per cent.

The values obtained are detailed below:

Sample No.	10	22	23	25	26	27	28
Total solids dried at 110° C.	6·0	6·7	10·8	7·9	8·2	5·0	10·0
Calcium (Ca)	0·48	0·7	0·72	0·36	0·56	0·25	0·61
Magnesium (Mg)	0·36	0·08	0·24	Less than 0·01	0·13	0·19	0·32
Sulphate (SO_4)	2·84	1·06	3·2	1·6	2·2	1·6	2·24
Chloride (Cl_2)	0·24	2·6	2·8	1·9	2·4	not estimated	

All quantities are expressed in gms./litre. In no case was the water alkaline to phenolphthalein.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: We welcome to-night a pioneer: not one who has sprung into sudden prominence by the successful accomplishment of a single journey, but one who by steady and long application to the knowledge of the country, its peoples, their language and their customs, has added very greatly in the last two years to geographical and kindred sciences, culminating in the first crossing of the Rub' al Khali by a European.

Mr. Thomas, having performed his duty with distinction during the war, found himself at its conclusion acting as a political officer in 'Iraq under Sir Percy Cox, to whom we shall listen with great pleasure later in the evening. From 'Iraq Mr. Thomas went to Transjordania, where he spent two years under the command of Mr. Philby. It was from there that he went to Muscat, where he has been for six years as financial adviser to the Sultan. He had always in his mind the possibility of making this unique third journey. The Rub' al Khali is that tract of country which lies to the north of the range of mountains bordering on the south coast of Arabia and to the south of the Persian Gulf. Some few have penetrated a little way from the south. You may remember that the Bents went there some years ago; Hirsch also and Captain Bosanquet and a few others; while

*R. E. Cheesman, 'In Unknown Arabia,' London (Macmillan and Co.), 1926, Appendix vii, pp. 422–5.

in 1929 Squadron-Leader Cochrane made what he correctly termed "An Air Reconnaissance of the Hadhramaut." It may be that an Arab or two has made the whole journey, but for the first time we shall hear to-night a description of the "Empty Quarter."

The audience at this meeting, Mr. Thomas, is composed, I may tell you, almost exclusively of Fellows of this Society. That will show the eagerness with which we await your lecture. The stage is set. The curtain rises on Arabia.

Mr. Thomas then read the paper printed above, and a discussion followed.

The PRESIDENT: To our great regret Sir Arthur Keith is unable to be with us this evening, but I will call upon Professor Seligman to speak from the anthropological point of view.

Professor SELIGMAN: I have had the honour of being asked to work up Mr. Thomas's amazingly interesting anthropological results. Directly I began to study his figures and photographs it was obvious that a wide field for discussion of origins and migrations was opened up. The actual people with whom Mr. Thomas dealt can be divided into two classes: the Arabic-speaking tribes and the non-Arabic-speaking tribesmen on the edge of the Sands, who nevertheless speak Semitic languages. As to the Arabs, these include a number of folk from 'Oman, fairly tall men with long oval faces, high round heads, and pronouncedly Armenoid—so-called Jewish—noses. Such men as those you saw on the screen from 'Oman agree precisely with the two 'Oman skulls in the Royal College of Surgeons, and bear out the conclusions that I arrived at some years ago from a general study of southern Arabia. But besides these there is a round-headed type with a straight, rather short, nose (not the so-called Socratic type of northern Arabia), which I am unable to place, and there are also a certain number of people whose photographs might well be confused with those of nomad Arabs from the steppe of Kordofan, though their head measurements show that they are rather rounder-headed than the latter.

Coming to the non-Arabic-speaking tribes, the first question is who they are, that is to say, to what racial type do they belong? Only after this has been settled is it reasonable to investigate how they reached their present home. On the screen at the moment are photographs of three men, the two outside being typical Armenoids in regard to facial characters—they are, in fact, just such roundheads and have such Armenoid noses as might be found in the Levant—while the man in the centre of the group is of a totally different type and certainly non-Armenoid. With regard to cephalic index, which, as you know, measures the proportion of head length to head breadth and is one of the most important criteria of race, the average index of twenty men speaking non-Arabic languages is 87·4, about two units higher than that of an Arabic-speaking group of eight. Excluding the tall 'Omani men, "Arabs" and "non-Arabs" have about the same stature (64–65 inches).

Summing up, we can only say that (omitting a small number of unusual types) there is no very outstanding difference between the Arabic- and non-Arabic-speaking groups; both are high brachycephals, and in both there are many individuals, in the photographs constituting definite majorities, with well-marked Armenoid noses. These southerners must then be regarded as predominantly of the Armenoid race, and this, as I pointed out in 1917, is the race to which the Arabs of south-western Arabia belong. There does not seem to be any reason for regarding them as Hamitic; indeed, they differ entirely in measurements and appearance from the Beja (Hamites) of the Sudan, while it is only necessary to glance at Mr. Thomas's photographs of Somali to see that in feature and general make-up they in no way resemble these.

Now how have these Armenoids reached South Arabia? Obviously they came from Mesopotamia, or from country even farther north, though their migration may have started so long ago that in details of feature they may well differ considerably from the present-day inhabitants of Mesopotamia. Nor can we ignore the results of miscegenation once the immigrants had reached southern Arabia. I stress these points because Mr. Thomas informs me that his South Arabians do not remind him of the Mesopotamians he knows so well. And, lest you may find a Mesopotamian origin somewhat difficult to accept, I may point out that on South Arabian coins of about 70–40 B.C. there are many representations of round-headed people. I would also emphasize that twice in mediaeval history there were movements of considerable bodies from Mesopotamia to South Arabia and *vice versa*. About A.D. 570 the Persians conquered the Yemen, and maintained a viceroy there for over fifty years, *i.e.* until 628. A few years later Khalid Ibn Walid, "the Sword of God," one of Muhammad's generals, starting from Arabia marched into Mesopotamia with what must have been a considerable following, although we know that his army was of no great size compared with that of the Persians he conquered.

That is all I can say at the moment, but I think the outline I have put before you fairly represents the main definite anthropological results of Mr. Thomas's wonderful journey. As bearing on these conclusions I may add that since Mr. Thomas's paper I have had the opportunity of discussing his photographs with the Abyssinian scholar and traveller, M. Marcel Cohen, who sees no suggestion of Abyssinian traits.

The PRESIDENT: I now call upon Dr. Calman, whose knowledge of zoology is surpassed by none.

Dr. CALMAN: I have been asked to say a few words about the zoological specimens collected by Mr. Bertram Thomas and presented by him to the British Museum, where they are now being studied by my colleagues. The natural history collections of the British Museum have been greatly enriched in the past by many of the travellers and explorers who, from time to time, have come before this Society to relate their adventures and announce their discoveries. It has often happened however that those journeys which have made the greatest demands on the intrepidity and endurance of the travellers have been least productive in this respect, for the obvious reason that the pioneer whose attention is occupied in finding his way and providing for the safety of himself and his party has often little time to spare for collecting purposes. It is all the more gratifying therefore to be able to tell you that, amid the distractions of the journey which he has just described to us, Mr. Bertram Thomas has been able to get together and bring home a collection of exceptional value and importance, embracing all the chief groups of terrestrial animals from mammals down to spiders. Coming as this collection does from a region hitherto unknown, it is not surprising to find that some of the less-known groups of insects, for example, are yielding a very considerable number of novelties, as they come to be studied in detail. What is surprising however is that even in such well-studied groups as mammals, reptiles, and butterflies Mr. Bertram Thomas has been able to discover a number of well-marked forms that are new to science.

While we are naturally very pleased at the discovery of new species and sub-species, an even greater service to science is rendered by those parts of Mr. Thomas's collection which have not this claim to novelty. Arabia, lying on the borders of three of the great zoological provinces into which the world is divided, presents problems of particular interest to the zoogeographer, and it is for the light that they throw on many of these problems that the new collections are specially important. We find, for instance, that the reptiles from the Qara

Mountains are all of African types, while farther to the north in the Rub' al Khali the reptiles are all Palaearctic species coming from the north. Of an Oriental or Indian element there appears, as far as the collections have been studied, to be little trace; the Indian Wolf, for instance, which we also know from Muscat and Aden, is a species of Palaearctic affinities, extending only into northern India. A temporary exhibit of a few of the specimens collected by Mr. Bertram Thomas has been placed in the Central Hall of the Museum, so that visitors may be able to see something of the results of his collecting.

The PRESIDENT: No meeting of such a nature as this would be complete without some words from Sir Percy Cox, and I now call upon him.

Sir PERCY COX: I am grateful for the opportunity given me to-night of paying my tribute both to the splendid accomplishment of which we have heard and to Mr. Thomas's outstanding qualities for exploration.

I have special reasons for being interested both in the subject of the lecture and in Mr. Thomas personally. As the President has told you, he served under me in 'Iraq, but I should like to explain that when he actually entered 'Iraq service (being transferred from the military to the civil side for political work with the tribes) it was while I was away on deputation in Tehran, and he was selected by Sir Arnold Wilson, who had taken over my duties when I left. I found Mr. Thomas there when I came back to inaugurate the High Commissionership, and it was at that period that he served under me. Later, when Mr. Philby was transferred to Transjordania, Mr. Thomas, thinking he would like a change, followed his fortunes there, and it was after a period of service in that country that he accepted the post of Financial Adviser to the Sultan of Muscat.

My second reason for having a special interest in this lecture is that I spent five years in 'Oman myself, and so naturally like to hear of all that passes in that region. It is now thirty years ago since I made a journey from Abu Thabi on the Persian Gulf Coast across the northern promontory of 'Oman, where the Rub' al Khali stretches out towards the north-east, and thence along the edge of the desert back to Muscat. En route I ascended the Jabal Akhdar range, and from the crest, from 7000 to 8000 feet high, I looked down with longing on the great wadis which flow down from the watershed of the Hajar Range and stream out like ribbons into the Great Desert. I do not suppose I saw the actual beginning of the Nafud, but there was nothing between me and it, except the distance, to limit the view, and I remember how I then longed, as I am sure every other Englishman who has travelled in 'Oman has longed, to solve the riddle of those great sands. I did indeed make serious inquiries on the subject and took numerous notes as to what the possibilities were, and how the crossing could be carried out, from east to west. The fundamental difficulty seemed to be that one was pretty sure to be scuppered on reaching the tribal fringe on the other side. Before I had got very far with my inquiries however I was promoted to Bushire and had no opportunity of pursuing the subject farther. But I think the idea of crossing from south to north was an excellent one and just as effective, for Mr. Thomas's route took him right through the centre of the desert, and I do not think that any fuller information would have been or will be gained by crossing the other way. We now know generally what the desert contains and consists of, whereas before Mr. Thomas's expedition our only measure of information was purely negative. We knew that certain Badawin tribes grazed into the edges of it, but except a few skins and an occasional captured antelope nothing ever came out of it. Now we know all about it; in fact, Mr. Thomas makes me feel very humble, because though I did a great deal of travelling in 'Oman it was in a small way, as an official; one's time was limited to two or three weeks as a rule, and it was difficult to do anything of much value. Mr. Thomas, on the other hand, studied before he went, and has

displayed extraordinarily good qualifications for exploration work. As you see, he took immense pains to collect natural history specimens; and he took sights and had an eye to the scientific aspects of his journey. A good deal of the ground covered by him in his earlier excursions I had myself passed over, but I find that I missed half the interesting things that he has told us of. In conclusion I should like to congratulate him on his splendid achievement and on his lecture of this evening and tell him how much, speaking as an old hand who has travelled in the same region, I admire the great efficiency with which he carried out his project.

The PRESIDENT: It would require expression far beyond my powers to make a proper appreciation of Mr. Thomas's work, his lecture, and all that he has done, in the few moments that I allow myself. When the book Mr. Thomas is writing is produced it will contain a wealth of information of a most absorbing interest that will put him in the front rank of travellers, keen observers, and most faithful recorders. Those who have read his book, 'Alarms and Excursions in Arabia,' and his articles in *The Times* will know that his book will be produced in the most attractive fashion. You have heard three men, each of them pre-eminent in the activities which occupy them—anthropology, natural history, and the administration of great policies—give great praise to Mr. Thomas; and I, on your behalf and on behalf of the Society, would like to endorse to the full every word that they have said. Though he travelled dressed as an Arab, he made no disguise either of his race or of his creed. He respected the religion of those with whom he travelled and they respected his. There is no doubt that the confidence which he inspired is something which will be of the greatest possible benefit both to this country and to all future travellers. Very interesting, too, in *The Times* is his reference to the communal spirit of people bred in conditions of great hardship and privation. Cross thousands of miles of the centre of Brazil and you will find exactly the same description of the people given by Mr. Dyott.

It is not for me to speak of the geological aspects; those are in the hands of the proper authorities, as you heard, and it is quite possible that we may be able to make a chart of the water-levels as has been done in the Libyan Desert by Dr. Ball. Of the survey work I can perhaps speak with greater authority. We are filled with admiration at the accuracy of the positions in Mr. Thomas's traverse, the positions of the wells, and numerous facts of that kind; and that very valued colleague of ours in this Society, Mr. Reeves, may dwell with pride on having had so apt a pupil.

I spoke an hour ago—it may be more: the minutes have passed with great rapidity—of Mr. Thomas being a pioneer. It is to pioneers that credit is due. I remember some years ago walking with General Smuts and hearing him say how hard is the way of the pioneer and how long it is before posterity gives him proper merit. Many present will remember how Dr. Hogarth used to speak of Gertrude Bell and of the journeys, now made easy, of which she was the pioneer. There are many others, too. Others will go to the Rub' al Khali and they will follow in Mr. Thomas's footsteps. I think they will say—I do not talk Arabic, but have borrowed a phrase from my friend Ja'afar Pasha—that Mr. Thomas has changed the name of the Rub' al Khali to the Rub' al Kamil.

The hour is rather later than we sometimes are, Mr. Thomas, but we would willingly have listened to you for much longer. With that I ask you to accept, on our behalf, not only our thanks but our unbounded admiration. Five weeks from to-day I shall have the privilege of presenting to Mr. Thomas the Founder's Medal—an award of which His Majesty has approved. Every Fellow of this Society will, as ever, welcome His Majesty's judgment in this matter.

THE GLACIAL DRIFTS OF ESSEX AND HERTFORDSHIRE, AND THEIR BEARING UPON THE AGRICULTURAL AND HISTORICAL GEOGRAPHY OF THE REGION: *A paper read at the Afternoon Meeting of the Society on 11 May 1931, by*

S. W. WOOLDRIDGE, D.SC., F.G.S., AND D. J. SMETHAM, B.SC.

THE glacial drifts of the English Plain already possess a very extensive literature on the geological side which concerns more particularly their constitution, succession, and origin. Less has been written on the subject of the control which they exercise on the geographical features of the country. It is recognized that East Anglia and parts of Lincolnshire and Yorkshire, as well as extensive tracts west of the Pennines, are almost entirely drift covered, and in these regions the influence of the drift upon topography, soil, surface utilization, and water supply is sufficiently evident. It can only be fully appreciated however by contrasting these areas with neighbouring lowlands, unglaciated or at least drift-free. When this is done it is found that the margin of the drift-country almost always forms a natural geographical boundary, not perhaps a hard line but a narrow zone of transition. Good examples of this are seen in West Norfolk where the drift-sheet terminates against the gently rising dip-slope of the East Anglian Heights; or again, in even more striking fashion, near Melton Mowbray, where the Lias of the Vale of Belvoir lies at the foot of the escarpment-like edge of the boulder-clay plateau near the line of the Fosse Way.

In the present communication we have sought to trace the similar contrast observable along the southern margin of the great drift-sheet of Eastern England, particularly in Hertfordshire and Essex. So far as we are aware no extended consideration has been given to the geography of this line, which is undoubtedly the most clearly marked natural regional boundary in the northern part of the London Basin, separating northern Essex from southern Essex, and eastern Hertfordshire from western Hertfordshire.

The extension of the glacial drift south-westward along the Vale of St. Albans carries the characteristic "drift" geography along a well-defined belt into western Hertfordshire, and gravels, closely associated both in character and age with the glacial drifts, occur in force along the northern side of the Thames Valley between the Colne and Goring Gap.

We need not pause here to consider in any detail the mode of emplacement of the drifts—a topic pertaining to pure geology, and one moreover concerning which considerable doubt still exists. It may be well to state however that in the following pages the glacial drift is treated as the product of land ice. On this view the boulder-clay must be regarded as "moraine profonde" formed beneath the ice, or, more probably as we think, following Lamplugh,* as the product of the slow decay of ice densely charged with detritus. Lamplugh regarded the shallow sea basins beyond our coasts as the areas of greatest ice accumulation and erosion, while "the thickest sheets of lowland drift were laid down where the ice . . . thinned off towards its periphery." In this view we concur. It carries with it the corollary that the boulder-clay is not coextensive

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with the former ice-sheet, having accumulated in a broad marginal belt round the centres of ice dispersal. The explanation of the outwash gravels presents no difficulty; it is worthy of note that the amount of such outwash is relatively small in the district under notice.

East of Hitchin the Chalky Boulder-Clay ice-sheet deploying fanwise from the region of the Wash overrode the Chalk escarpment, and no doubt it descended the Chalk dip-slope normally in the direction of greatest slope. Within the Tertiary country however it entered a region of irregular relief in which relict hills diversified a surface already far advanced towards base-levelling. Here it split up into various tongues whose distribution and motion were controlled by the form of the ground. In short, it would seem that the Tertiary uplands ranging westward from Danbury through Brentwood and across the Lea into Hertfordshire acted as a vast fender holding the mass of the ice off from the region of the present Thames valley, but allowing narrow ice-lobes, which must have had the dimensions and appearance of true glaciers, to push through the gaps between the several masses of high ground. Thus, in the west, the ice-sheet split on the north-eastern angle of the South Hertfordshire plateau, sending one branch along the Vale of St. Albans and another down the lower Lea valley. In Essex, the Epping Forest ridge separated the Lea valley lobe from that of the Roding valley. Farther east a long ice-lobe projected southwards to Upminster between the high ground of Havering and Brentwood.

Another lobe occupied the low ground between Brentwood and Billericay. These several lobes in western Essex are disposed in a radial manner about a centre lying in the region of the upper Stort and Roding valleys, and it would seem that the check to movement imposed by the barrier of high ground resulted in some measure of congestion in this depression, rendering it a separate subsidiary centre of ice dispersal. In eastern Essex, where the ice-sheet advanced into low flat ground, the margin is not lobate but follows a simple course from Chelmsford eastwards.* The boulder-clay of the main mass and of the several lobes and tongues has been subject to a relatively small degree of post-glacial dissection. Associated outwash gravels appear beneath it in valleys trenched through the sheet and locally extend far beyond its boundary. Their distribution is treated in more detail in the sequel. The characters of the drift-margin may best be treated under the following three regional headings:

A. Eastern Hertfordshire, where the drift country gives place to the normal Chalk plateau.

B. The Vale of St. Albans, where the drift extends south-westwards, with Chalk on its northern and London Clay on its southern side.

C. Southern Essex, where the edge of the drift lies on London Clay throughout.

We may begin our survey of the drift boundary at Hitchin where it crosses the Chalk escarpment. Fig. 1 illustrates the striking change in the position and morphology of the escarpment which takes place here. Westwards for a distance of nearly 20 miles it is a bold feature constant in strike. Its morphology

*For a detailed account of the glaciation of the district see S. W. Wooldridge, *Essex Naturalist*, vol. xxi (1927), p. 257.

is complex in detail since it is breached by several windgaps, as well as by the marked salient about the Lea headwaters near Luton, but the range is essentially continuous. The summit level falls steadily from 845 feet beyond the Buckinghamshire border to 602 feet at Telegraph Hill above Hexton.

The Hitchin Gap is 6 miles wide at its mouth near Hitchin, and on its eastern side the Chalk escarpment exhibits a complete transformation in form and relations. Its summit-level is much lower, rarely exceeding 500 feet, and it is capped by boulder-clay to the summit. It is set back some 4 miles south-eastward of its former line of strike, and from its foot there stretches a broad low-lying outcrop of Lower Chalk (Chalk Marl) which forms part of the Vale of Baldock. Its outline is characteristically subdued as compared with that of the escarpment to the west. This is clearly the area in which the change from the Chiltern Hills to the East Anglian Heights may most appropriately be deemed to take place. The change in the character of the escarpment is to be

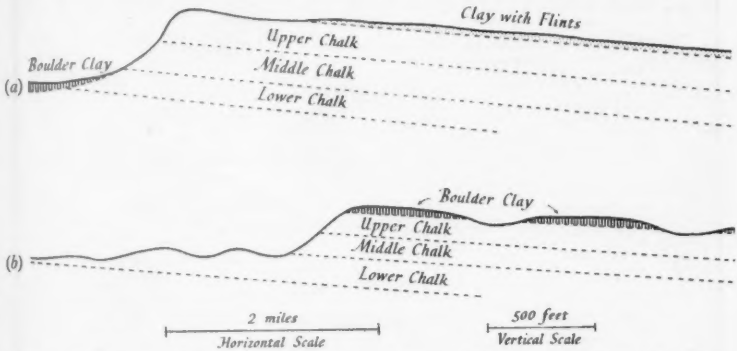


Fig. 1. Form of the Chalk Escarpment (a) west (b) east of the Hitchin Gap

attributed largely, if not entirely, to the onset of the ice east of the Hitchin Gap, whereby the face of the scarp was pushed back, and the chalk marl plain at its foot formed. The latter is essentially drift-free, and is to be regarded as complementary to the boulder-clay sheet to the south, in the sense that its formation provided much of the material deposited beyond the escarpment crest as the chalky boulder-clay.

The map (Fig. 2) illustrates the distribution of the glacial deposits (boulder-clay and glacial gravels grouped together) on the chalk dip-slope. East of the Hitchin Gap the plateau surface is covered by boulder-clay, though several wide valleys expose the underlying chalk, and a few patches of clay-with-flints appear in the west. West of the gap the higher parts of the plateau are uniformly covered with clay-with-flints and plateau brickearth. The floor of the gap is filled to a great depth with glacial gravels. The actual western edge of the drift runs south-eastwards from near Hitchin past Stevenage, and finally turns through a right angle into the Vale of St. Albans. The difference in soil character between the plateau areas east and west of the gap is in itself sufficient to determine appreciable differences in geographical character, but the contrast between the two regions does not reside only in soil.

The sections, taken transverse to the gap and its continuing valley (Fig. 3), indicate how plainly the glacial limit is marked in the morphology. The ridge

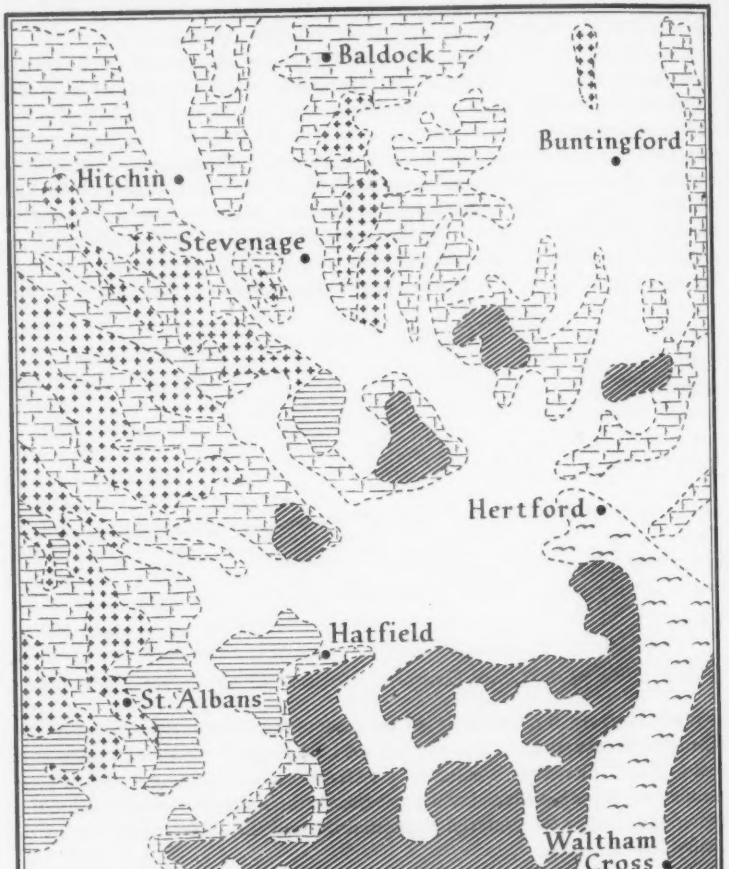


Fig. 2. Distribution of Glacial Deposits near the Hitchin Gap

running from Offley through Preston to Knebworth and beyond presents a steep face to the east, and rises to a greater height than the boulder-clay plateau at Weston on the opposite side of the gap. It is a most marked physio-

graphic line, conspicuous both on the map and on the ground, and may be regarded as marking the easterly limit of the typical Chiltern plateau. To the west the plateau rises to greater heights than are reached to the east, and the valleys are straighter, more closely spaced, and steeper sided. The general effect is to produce a topography markedly more accidented in the western or extra-glacial region. The subdued contour of the eastern plateau derives only partially from the smothering or levelling effect of the boulder-clay sheet. Its different morphology doubtless reflects in part the operation of glacial scouring and planation. Farther to the south the contrast between the two sides of the Beane valley is emphasized by the occurrence of a line of conspicuous Eocene outliers on the west, at St. Albans, Ayot, and Harmer Green. The line of outliers certainly persists for some little distance to the east, but it soon fails, and the outliers which do occur are partly obliterated by the boulder-clay mantle.

An even more important difference between the two regions appears in their hydrography. All the valleys in the east contain flowing streams, but on the

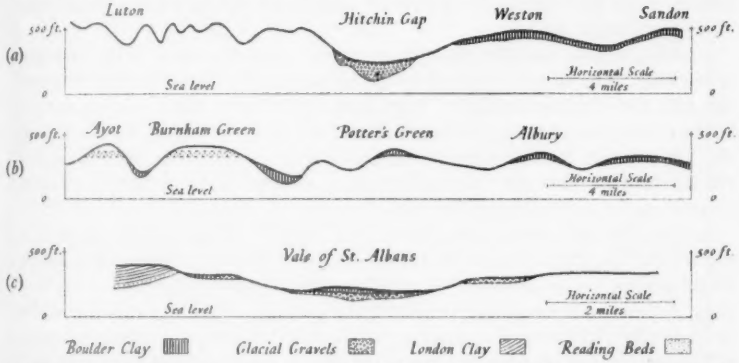


Fig. 3. Profile sections across the margin of the drift-lands: (a) and (b) transverse to the line of the Hitchin Gap, (c) transverse to the Vale of St. Albans

west, while there is a complex system of valleys, they are all dry, with the exception of those of the main consequent streams. The reasons for this hydrographical difference are not entirely clear, for there does not seem to be any systematic difference in the position of the water-table. On the other hand, the boulder-clay is an effectively porous stratum over wide areas, emitting springs at its base and at other levels, and these, no doubt, serve to maintain a surface flow above the point of emergence of the purely Chalk springs. But whatever the cause of the difference, its effect on the habitability and early settlement of the eastern region is sufficiently plain.

Passing now to the Vale of St. Albans, we find that the drift forms a parallel-sided strip about 5 miles wide. The boulder-clay is confined to the lower parts of the floor of the vale, extending as a broad dissected tongue as far west as Aldenham. The subjacent gravels are thick and continuous and extend beyond the boulder-clay tongue to Watford and beyond. They are disposed in two terrace-like spreads, one flooring the vale and the other, more dissected, forming a step at a higher level, better preserved on the northern side (Fig. 3). The

boundaries of the drift on either side of the vale are distinctly marked. On the south rises the so-called Tertiary escarpment, the edge of the dissected clay plateau of South Hertfordshire. The latter region is drift-free, if we exclude some thin patches of high-level gravels of pre-glacial date which have little influence on soil or surface-features. The boundary on the north is distinctly more remarkable though no more striking in its geographical expression. Here the drift rises to an elevation of about 400 feet and terminates along a very nearly straight line which runs south-westward from near Welwyn, passing slightly north of St. Albans and thence onwards past Chorley Wood to Beaconsfield, finally emerging on the northern slope of the Thames valley near Marlow. Throughout this long range the boundary maintains a strikingly uniform elevation, and it corresponds with a soil change of the most drastic character. Beyond, on the Chiltern dip-slope, nothing but clay-with-flints and kindred argillaceous materials occur on the plateau surface, but as soon as the drift-line is crossed we enter a region of deep sandy and loamy soils, which, while locally stony and sterile, have proved capable of yielding under treatment excellent farming land.

Finally, we may note the curiously symmetrical arrangement of the drainage in the vale. The latter is drained by the subsequent portions of the Colne and the Lea, flowing westwards and eastwards respectively. Each gathers a share of the consequent drainage of the Chiltern dip-slope, the Chess, the Gade, and the Ver entering the Colne; while the upper Lea, the Mimram, the Beane, and the Rib take the eastward route. This simple arrangement has exercised its due control on the settlement of the area.

In Essex the topographic expression of the drift boundary shows considerable variations from that noted in Hertfordshire. In the latter area the drift generally abuts against rising ground; but in Essex this is rarely the case. The map (Fig. 4) presents a simplified version of the geology of the region, and enables us to distinguish the varying character of the drift boundary. In the south-west of the county the boulder-clay rests directly on the London Clay, associated gravels being absent or subordinate. It lies for the most part at relatively high elevations, capping the ridges, and the sheet is much dissected owing to the proximity of the Lower Lea and Roding valleys of which the various phases of rejuvenation have affected the whole area.

East of Brentwood the edge is still very irregular and gravels again are absent. The boulder-clay here rests in the broad cols between the outliers of Bagshot Sand. Between Chelmsford and Colchester however a marked change takes place in the general geological and physiographic setting, for large masses of gravel appear from beneath the boulder-clay and occupy extensive tracts in front of its edge. The hills at Danbury, continued beyond the Blackwater in the curious ridge of Tiptree Heath, follow the axis of this gravel terrain. This is the only part of the county in which the limit of the drift is marked by any clear topographic feature. It has been suggested* that the Tiptree Ridge is morainic in character, but though its situation and relations lend some colour to this hypothesis more investigation is required before it can be accepted. Finally, in the Tendring Hundred, the area between the Colne valley and the coast, the boulder-clay edge retreats northwards into Suffolk and the place of

*F. W. Harmer, 'Geology in the Field,' vol. i, p. 122.

the frontal gravels is taken by an extensive sheet of loam, which caps the low plateau of London Clay.

Certain variations are to be observed also in the character of the drift country itself in central and northern Essex. Between the Stort and Chelmer valleys the boulder-clay sheet is not broken through by the valleys, and a characteristic uniformity of surface results. It rests on London Clay without intervening gravels, and the twin head valleys of the Chelmer give rise to an *enclave* of true London Clay country in the centre of the drift plateau. To the east the parallel valleys of the Blackwater, Colne, etc., reveal the northward continuation of the frontal gravel sheet, the boulder-clay being confined to the summits of the broad interfluwe ridges. The presence of extensive gravel tracts considerably modifies the character of the country. In particular the presence of

Fig. 4. Geology of Essex (*simplified*)

these porous beds reduces the closeness of texture of the drainage system as compared with that of the boulder-clay area to the west.

A driftless London Clay lowland intervenes between the edge of the glacial drifts and the broad belt of the Thames alluvia which borders the northern side of the river. This lowland is narrow and irregular in the west but broadens eastwards into a curious flat-floored trough which trends north-eastwards across the line of the Crouch valley to the Blackwater estuary. It is continued beyond the latter in the area around the Tolleshunts, though this outlying portion of the London Clay terrain has significant characters of its own. It is a fact of great geographical importance that the drift boundary approaches the coast so nearly in eastern Essex and that the navigable estuaries of the Blackwater and the Colne give natural and direct access to it.

One very important physical character of the drift lands both in Essex and Hertfordshire is the readiness with which they yield a supply of water from shallow depths. The early settlement of the English Plain depended upon the

availability of a water supply as much as on any factor. Excluding the regions of the scarp-foot springs there are few areas so favoured in this regard as those of the glacial drifts. Shallow wells yielded adequate supplies of water throughout northern Essex and eastern Herts for hundreds of years, until, in fact, within recent times it became necessary to guard against contamination and secure a generally higher purity. This water was obtainable both from the gravels and from the boulder-clay itself which in virtue of its heterogeneous constitution is often water-bearing. The presence of a boulder-clay capping protects the gravel waters from contamination in many cases. Even where the base rock is chalk a separate water-table is generally maintained in the gravels owing to the check in the downward percolation that takes place at the gravel-chalk junction. In contrast to these conditions we may note that over the Chiltern plateau the water-table in the Chalk is rarely less than 200 feet below the plateau surface and generally more than 100 feet below the floor of the smaller valleys. Again, the London Clay outcrops were effectively waterless areas, so far as underground supplies were concerned, until the era of deep wells.

In the foregoing paragraphs the physical contrast between the drift lands of Essex and Herts and the tracts which border them has been outlined. In pursuing this contrast into the sphere of human geography, we must first emphasize the fact that soil differences have been the most important factor in the geographic development, the hydrographic and morphological factors filling an important though secondary role. The essential fact concerning the drift lands under consideration is the ease and profit with which they have been cultivated, and it is therefore desirable to devote some attention to their soil features.

The geological map distinguishes three categories within the "glacial" drift: boulder-clay, glacial gravels, and loam or brickearth. This simple threefold grouping fails adequately to indicate on the one hand the wide variability of the resulting soils and on the other their underlying unity of character. In this we find illustrated at once the rather crude and ineffective nomenclature of sedimentary petrography and the prime need of soil maps for geographical work. Both aspects of the case are at present receiving attention, but it will be many years before the leeway in these branches of knowledge is appreciably made good. Meanwhile it is beyond the compass of individual workers to make soil surveys of large regions, a task which needs cooperative effort. We propose in this case to submit certain general facts and conclusions based upon a survey of the whole area in outline, together with the detailed examination of a selected tract round Welwyn in Hertfordshire where the several types of glacial drift together with the chalk, clay-with-flints, and Eocene beds are exposed in close juxtaposition.

The boulder-clay is the most extensive of the glacial drifts of the region. Its general characters are well known and need not be described, but several important points concerning its variations demand attention. The term "clay" is frequently all but a misnomer, "stony loam" would more nearly describe it over wide areas. Moreover the removal of the finer particles by long-continued rainwash on gentle slopes concentrates the coarser constituents and gives rise to a soil consisting of stones in a silty base not unlike the soil derived from the gravels. Interstratified beds of sand and gravel ensure further departures from

the true clay type. Even more important is the fact that the character of the boulder-clay inevitably depends in part upon the immediately subjacent rocks. In all cases there is a far-travelled element in its composition, homogeneous, well mixed and uniform over wide areas, and a local element whose nature and amount varies widely from place to place. Thus it is a fact familiar to geologists that the typical chalky boulder-clay of northern Essex and southern Suffolk gives place beyond Ipswich and Bury St. Edmunds to a "chalky Jurassic" boulder-clay in which débris from the Jurassic clays becomes conspicuous. In the area under notice an equally important variation is seen, but one to which less attention has been given. The ice was here moving transversely to the rock outcrops and the boulder-clay sheet lies across the boundary of the Chalk and the Eocene beds, largely concealing it. The concealed boundary runs from Hertford *via* Bishops Stortford and Thaxted to Sudbury. Thus in eastern Herts the main mass of the boulder-clay rests on the chalk except between the valleys of the Stort and the Ash. In western Essex it rests upon the London Clay. As a consequence in Herts the boulder-clay is dominantly chalky while containing a sufficient admixture of far-travelled elements to yield a soil richer than that derived from the chalk itself. The dominantly chalky character persists for some distance across the Eocene outcrop, but increasing quantities of London Clay are present in the mass involving a marked change of character. Hicks* observed many years ago at Hendon and Finchley that the boulder-clay, though containing an appreciable chalky basis, was locally little more than reconstructed London Clay, large masses of the latter having been bodily incorporated by the ice. Thus it is that the southern margin of the boulder-clay tracts gives a colder and wetter soil less suitable for cultivation than the true chalky boulder-clay, though superior to the London Clay itself. In other words, there is a natural transitional zone which blurs but does not destroy the sharpness of the geographical contrast. The true chalky boulder-clay is to-day largely under cultivation, while those portions contaminated with Eocene material (chiefly London Clay) have reverted in part to pasture. The reality of the distinction is well brought out by a comparison of the country round Buntingford and the Pelhams with that round Hunsdon and Widford. It is further illustrated by the contrast between the boulder-clay at Harlow, still highly chalky, and that which covers the Epping ridges only 5 or 6 miles to the south. In the latter area and again west of the Lea above Waltham and Cheshunt the boulder-clay country is marked off by no salient characteristics from the surrounding tracts of bare London Clay. Recent sections on the main road north of Epping have exhibited the boulder-clay highly charged with London Clay and relatively poor in chalk.

Before leaving the subject of the boulder-clay soils we may note that east of the Chelmer valley and again in the Vale of St. Albans the boulder-clay rests on its own proper lower member, the outwash gravels, disposed in front of the ice and subsequently overridden. Here it is to a large extent insulated from the local base rock, local variations in character are subdued and its "geographical contact" with the London Clay is correspondingly abrupt.

Passing now to the glacial gravels we have to deal with another extremely variable accumulation whose accepted name not infrequently belies it. Taken

**Quart. Journ. Geol. Soc.*, vol. xlvii (1891), p. 575.

as a whole the gravels tend to be loamy, containing a large proportion of interstitial silt and clay as well as definite interstratified clay beds. The resulting soil is rarely so dry and acid as one might expect and, as noted above, often differs but little from the boulder-clay soils. Locally, as around Hitchin and west of Hertford, sand predominates over gravel, but even here the soil is loamy. Heathland is subordinate throughout the area and there is no approach to the "breckland" type. It may be noted that locally the glacial sands and gravels are highly calcareous, though of course they readily suffer surface decalcification. On the whole there is good justification for grouping the gravels with the boulder-clay as yielding broadly similar soils. The gravel soils are on the whole less favourable to arable cultivation than the best chalky boulder-clay soils, though locally at least they are superior to the "Eocene" boulder-clay. For instance, in the Symonshyde area between Sandridge and Welwyn the boulder-clay is left under pasture and woodland while the gravel soils are ploughed. It is further important to notice that the place of the gravel soils in the agriculture of the region has changed during the last century. Arthur Young, Secretary of the Board of Agriculture, in reporting on land farmed by himself at North Mimms in 1804, spoke very unfavourably of the gravel soils of the Vale of St. Albans. He characterized this district as "the most unfertile that we find in the south of England" and spoke of the wetness or "spewiness" of the soil due to the many springs. He further noted that it yielded to manuring when drained but that the benefit was soon lost. The change in the value of the soils followed from the fact that they were warm and light and that their natural infertility could be made good at small cost with London stable manure. This character has more than outweighed their lack of inherent richness and, in the words of Sir Daniel Hall,* they have proved that they can "rapidly convert expenditure on manures into crops commanding a good price." In the Vale of St. Albans the ready availability of water-borne manures from London as well as the proximity of the London market undoubtedly favoured the cultivation of the gravel tracts. The gravel areas of eastern Essex are in a less favoured situation and have never been cultivated to the same extent. To-day they include some of the few large stretches of heathland in the whole area (*e.g.* Danbury Hill, Tiptree Heath).

The third category of glacial drift shown on the published maps is designated "Brickearth (Loam) and Laminated Clay." Its origin, whether through the agency of water or wind, has been deemed somewhat problematical. There is no doubt however that much of it is a true wind-blown loess, though the laminated variant has evidently been deposited in standing water and various small patches on the boulder-clay surface may represent "kettle-holes" filled with rainwash, the complement of the static washing process. The representation of this class of material on the geological maps is far from satisfactory, though one can feel every sympathy with the surveyor in dealing with so vagrant a class of drift. The largest mapped expanse occupies the western part of the Tendring Hundred near Colchester. Small areas are indicated at various places on the Essex boulder-clay sheet near Witham, Finchingfield, and elsewhere. Of more importance are the large tracts shown on the $\frac{1}{4}$-inch Index Map (Sheet 16) on the floor of the Vale of St. Albans, west of Hatfield.

*'Victoria County History of Hertfordshire,' vol. 2, p. 135.

Though not separately distinguished on the new 1-inch Drift Sheet (No. 239) the reality of these spreads is not in question. The thickness is here about 4 feet and the deposit rests on boulder-clay. Finally we must note the occurrence of extensive tracts of a similar loam on the Chalk plateau round Caddington and Pepperstock near Luton. It is here that the evidence for aeolian origin is strongest, for the deposits are at an elevation of 500–600 feet above the sea and yield palaeolithic implements which date them as younger than the neighbouring deeply cut valleys. In the light of these facts Worthington Smith's suggestion* that they are lacustrine must in any case be abandoned. Identical deposits range across the Chiltern plateau beyond the confines of Herts into Bucks. Lithologically and geographically they differ in no important respect from the valley brickearths of the Thames, Lea, etc., for which an aeolian origin may also plausibly be argued. Questions of origin aside however these loams provide an ideal soil for arable farming, and their influence on the economy of the countryside has been marked. The contrast which the upland loams present to the stiff and intractable clay-with-flints associated with them is particularly notable, for the latter though a good arable soil tends to be cold and late and is distinctly more difficult to cultivate. The well-known map with which Vidal de la Blache illustrates his 'Tableau de la Géographie de la France' sufficiently emphasizes the importance of the easily cleared and readily cultivated "loess" and "plateau limon" soil. The existence of such loams is indicated on his map within the East Anglian region, but we are here suggesting that the loess belt has a more extended westerly range and that it should be reckoned as an important factor in agricultural economy and historical geography at least as far west as the eastern part of the Chiltern plateau.

Before leaving the subject of soils a word may be said regarding the clay-with-flints, which in its true and typical form is a simple dissolution residue of the chalk. It yields a soil of great inherent fertility but difficult to work unless it be chalked. It was formerly the custom to obtain chalk from small "bell-pits" sunk in each field and to spread it liberally on the land. Uncultivated land on the Rothamstead Estate proved to retain only 0·1 per cent. of calcium carbonate, while cultivated land benefiting from former chalking had as much as 5 per cent.† The soil is naturally cold and badly drained; chalking by coagulating the clay renders it warmer and earlier and facilitates drainage. Without it cultivation would have been virtually impossible in many areas. The practice of chalking has been largely discontinued owing to increased labour costs and the clay-with-flints soils have fallen from favour compared with the more easily worked and manured soils of the glacial drifts. Some boulder-clay areas it is true needed chalking owing to surface decalcification, especially where the drift is of Eocene provenance. However from our present standpoint the boulder-clay yields a soil distinctly superior to that of the clay-with-flints, and it is probable that the degree of agricultural differentiation between the eastern and western plateaux in Herts would have been greater than it is had it not been for the widespread association of the plateau loams with the clay-with-flints.

We may proceed to inquire how far the soil features outlined above are reflected in the present agriculture of the region. The accompanying maps

*W. Smith, 'Man the Primeval Savage.' London 1894.

†Sir D. Hall, 'Victoria County History of Herts,' vol. 2, p. 130.

(Figs. 5 and 6) are based upon the parish returns for the year 1911. Their aim is to show the balance existing in the several parts of the region between arable and pasture acreage. Some difficulty was experienced in selecting the year for treatment as economic causes have substantially modified the arable acreage within the region. There are two possible ways of regarding the operation of the economic factor upon our problem. Agricultural depression might lead to the limitation of arable farming to the regions of optimum conditions and a map constructed for such a period would then serve to localize these optimum conditions. On the other hand, a period of relative prosperity would presumably lead to the expansion of cultivation to the practicable limits set by soil distribution, and this might conceivably better serve the purpose of defining our

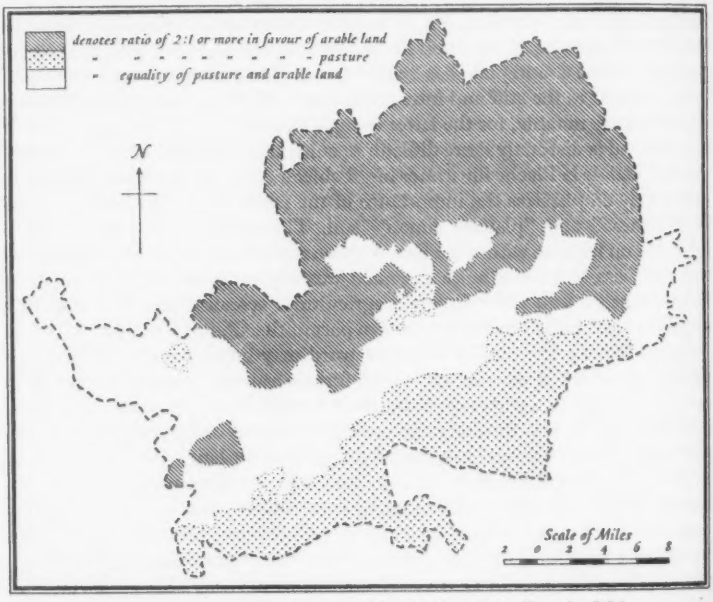


Fig. 5. Ratio of Pasture and Arable Land in Hertfordshire

regional boundary. Unfortunately the tracing in detail of the changes in arable acreage is a prohibitively expensive research. We have therefore taken the five pre-war years, 1909–13, and using the county returns as a basis selected the year, viz. 1911, which was nearest to the average of the five in respect of arable acreage. We have analysed the 1911 parish returns for an area covering practically the whole of Hertfordshire, Essex south of a line through Dunmow and Braintree, and the contiguous parts of Middlesex.

Reference to Fig. 5 shows that the area of dominant pasture in Herts (dotted on the map) lies on the London Clay in the south of the county. Its northern limit follows the edge of the drift in the Vale of St. Albans with great fidelity. While it is now only just beyond the suburban fringe of London it still retains

the characters of a true "hay country" in large measure. The ratio of pasture to arable acreage is 2 : 1 or more throughout the area so defined, frequently reaching figures of from 4 : 1 to 7 : 1. The Ayot Eocene outlier lying north of the main escarpment also appears as an area of dominant pasture. The area of predominant arable land (shaded on the map) lies chiefly on the boulder-clay plateau east of the Offley–Preston line, which thus contrasts effectively with the chalk-clay-with-flints area of the west of the county. Throughout the area of dominance the ratio is everywhere 2 : 1 or more in favour of arable land, and 3 : 1 may be regarded as the typical figure for the region. It shows however two significant departures from simple accordance with the drift boundary we have traced. In the first place it extends westwards up to and beyond the line of the Lea valley south of Luton. In this we perceive the influence of the high-level plateau loess which, as already noted, is particularly well developed in

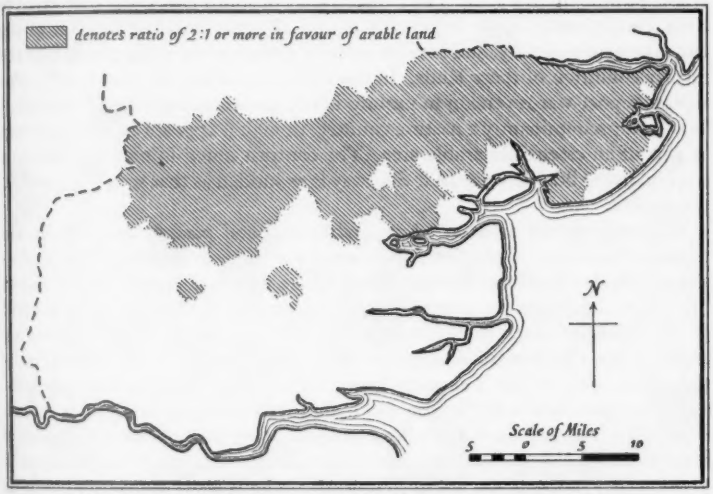


Fig. 6. Ratio of Pasture and Arable Land in part of Essex

this area and which extends the area favourable to arable cultivation beyond the line of the glacial drifts. Secondly, there is a decrease of arable acreage towards the south of the boulder-clay tract where several large parishes fall within the 1 : 1 category. In the west the parishes of St. Paul's Walden and Knebworth lie chiefly on the clay-with-flints, and no further explanation of their features is required; but in the parishes of Albury, Benington, and Standon and the area north of Hertford generally we see the result of the southerly increasing contamination of the boulder-clay with Eocene débris and the resulting provision of a less suitable soil. The gravels of the Vale of St. Albans constitute a transitional area between the tracts of predominant pasture and arable farming, the ratio here being approximately 1 : 1.

In Essex wholly comparable features of distribution are shown. In Fig. 6 the areas are shaded in which arable land predominates (ratio at least 2 : 1). The limit of the main tract runs from the Hertfordshire boundary near Harlow

past Ongar and Chelmsford and thence irregularly eastward to the coast in the Tendring Hundred. Thus it clearly follows the margin of the main mass of boulder-clay and of the loams of the Colchester district. The southern dissected fringe of the boulder-clay, particularly in the south-west of the county, falls beyond the area so delimited, and, as in Hertfordshire, the reason is to be sought in the deterioration of the boulder-clay soils within the Eocene outcrop. A marked re-entrant occurs in the edge of the arable country near Chelmsford. This is accounted for by the prevalence of gravelly soils, largely in low-lying situations (parishes of Boreham and Little Baddow, etc.) which are less favourable to arable cultivation than the surrounding boulder-clay. An anomaly less easily explained is the extension of the arable country on to the London Clay north-east of Maldon. There is no special peculiarity of soil other than a slight local lightening by gravel to account for the persistence of arable farming in this area. The London Clay of south Essex was cultivated to some considerable extent before the period of agricultural depression of the late nineteenth century, and here we seem to witness a surviving example of the former condition of these lands. In the same connection we may note a considerable post-war reversion to pasture in the gravel area south of Colchester. It is now predominantly a pasture country, though it appears on the 1911 map as part of an essentially arable area. The contrast noted in passing from this tract on to the boulder-clay near Stanway is as sudden as that seen anywhere in the county.

We may note the areas in which arable land and pasture respectively are strongly dominant. The chief arable areas are three in number. The undissected boulder-clay tract already noted in the west and known locally as the "Rodings" figures as one of these. It is separated by the London Clay enclave of the Chelmer valley from a long straggling area lying athwart but mainly north of the Chelmsford–Colchester road. Finally there is the clearly individualized area of the Tendring loams. The largest area of strongly predominant pasture lies in the west and includes the environs of Epping Forest. Thence an irregular band stretches eastward along the London Clay outcrop as far as the Blackwater estuary. It is noticeable that at the time in question the London Clay of Essex was not so completely under pasture as that of Hertfordshire. The zone of transition showing approximate equality of pasture and arable acreage, and thus analogous to the Vale of St. Albans, is well developed in Essex. As in Herts it is located partly on gravel outcrops, but large areas of London Clay and of "Eocene" boulder-clay are also included within it.

Although the foregoing agricultural survey is based upon the figures for a single year it illustrates the part which physical factors, and more particularly soil factors, play in the life of the region, for the conditions shown on our agricultural maps are still reproduced in all essentials. Moreover these same factors cannot have failed to exercise an important control on past phases in regional development, for agriculture has been the foremost "industry" of the area since the days of its first settlement. Accordingly we may now attempt to assess the importance of the drift boundary as a factor in the historical geography of the region.

An inevitable element of speculation enters into any reconstruction of the earlier phases. In the light of later events however it seems wholly reasonable

to assume that a beginning was made in the clearance of the drift lands at a very early date. It is virtually certain that the original forest of the drift lands was thinner in character and more easily cleared than that on the heavier clays. On the Ordnance Survey map of Roman Britain an attempt is made to indicate roughly the state of the vegetation of the country at that date, but within our region several points of interpretation seem open to question. In Essex the areas of Bagshot Sand figure among the few supposedly free from woodland. Actually the sands are so fine that heathland is practically absent. The soil is

Fig. 7. Distribution of Woodland in Hertfordshire

not sandy in the ordinary sense and there seems no reason why these areas should not then have supported forest growth as they do to-day in most cases. The main Chiltern tract is also shown as open country on the Roman map, but in fact the areas of clay-with-flints must certainly have supported oakwood as they do to-day. It is a surprising feature in several geographical and anthropological treatments of South-East England that the chalk areas are relegated *in toto*, or very nearly so, to the category of open downland, whereas in actual fact such a character is often conspicuously absent. True downland hardly

appears at all on the range of the North Downs east of Guildford save on the very face of the escarpment. Similarly in the Chilterns it is confined to the face for the most part, though it locally extends over the crest. The one locality in which we might expect some extension of treeless country down the dip-slope is in the boulder-clay areas. It must be remembered that in the north of our area the boulder-clay often contains little else but chalk, and its soil, though tending to be somewhat thicker and richer than that of bare chalk, is closely kindred to that occurring on the latter. The boulder-clay areas are now so thoroughly divested of even semi-natural woodland that little direct evidence is to be had (Fig. 7). It is not of course contended that the whole drift area was treeless, but merely that certain more elevated tracts near the escarpment edge may have extended the open country to the south and have afforded a natural invitation or entrance to the light woodland country farther down the slope. The boulder-clay plateau of eastern Herts nearly reaches the line of the Icknield Way between Baldock and Royston. Thence north-eastward this ancient trackway parallels the western edge of the boulder-clay all the way to Brandon in Suffolk, and would thus have afforded a natural line of approach to the readily cultivated area, an area barely inferior to the chalk-marl plain itself over which the trackway runs. It seems, then, not unlikely that Neolithic cultivators made some beginning in the clearing and utilization of the boulder-clay lands. However this may be, there can be no doubt that the late Celtic or British tribes, and more particularly the Belgae from Gaul, settled in the boulder-clay country.

Several geographically significant facts can be gleaned from our scanty knowledge of the British tribes immediately prior to and after the first Roman invasions. Hertfordshire was shared between two of these tribes, the Catuvellauni (the Cattyeuchlani of Ptolemy) on the west with their capital at St. Albans, and the Trinobantes whose territory included most of present-day Essex. Eastern or boulder-clay Hertfordshire seems thus to have been grouped with its appropriate natural region, and though we have no knowledge of any precise intertribal boundary, if such existed, it may well have had some relation to the marked change in the character of the country which we have already noted. From Caesar's own account the interesting point emerges that the Trinobantes were the most powerful and prosperous tribe in the district, and among the few that paid a tribute in corn. There is no doubt that the country was effectively farmed.

Further suggestive light is shed by the condition of Britain after the Claudian invasion and settlement. On the map (Fig. 8) the drift boundary is shown in generalized form together with the Roman roads and the location of all evidence of permanent settlement.* We note particularly the concentration of evidences of settlement within the drift area including all the larger towns except Londinium, and the paucity of such evidences upon the London Clay, particularly in Essex. A further point of considerable interest is the way in which the roads serve to integrate the drift region, suggesting that here lay the most thickly populated portion of the province near to London—a region cut off from London and the Thames valley by thick woodland and marshes. From

*The information has been compiled from the Ordnance Survey Map of Roman Britain.

London three roads lead to the main area of the drift country and only one north-westward towards the distant provincial frontier. All parts of the drift area are effectively linked by roads, the Colchester road following close to the southern margin, while Stane Street took the axial line from east to west. At or near Braughing in the west centre of the drift tract six roads met, a greater number than at any of the larger centres except London. Much has been written concerning the factors which controlled the selection of London by the Romans as a base for penetration and organization. The many good reasons which have been adduced for the selection of a crossing-place here* rather than at points east or west can be supplemented by a powerful consideration based upon the relation of the site to the critical drift region. A more easterly crossing, apart from all other difficulties, would have been confronted by a strip of London Clay forest which, though narrow, might well have ranked as a physical barrier. A more westerly crossing might have served for a route to St. Albans and the north-west, but in respect of the focal area it would have

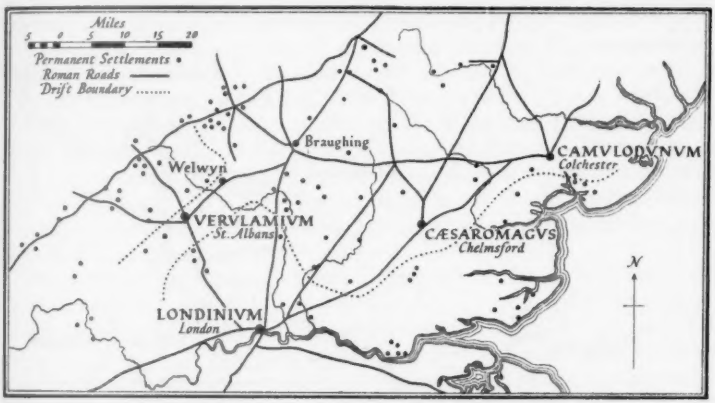


Fig. 8. Eastern portion of the London Basin

increased distance and diminished ease of access. It was not, as it seems to us, a question merely of contact with Verulamium and Camulodunum which confirmed the position of London as the growing commercial or administrative centre, but rather of accessibility to a relatively thickly populated agricultural area with well-marked natural boundaries, in which these two towns were important natural foci. London became the capital of its region at a time when its immediate environs were relatively waste and void, and when its function was to act as focus for sub-regions which lay round the periphery rather than near the centre of the main physiographic basin. Prominent, perhaps first, among such sub-regions was the Hertfordshire–Essex driftland. This relation held in Roman times and in large measure remained true for hundreds of years afterwards.

The evidences available for detailed geographical interpretation of the Saxon settlement, here as elsewhere in Britain, are lacking in precision. It is a familiar

*See *e.g.* V. Cornish, 'The Great Capitals' (London 1923), pp. 210 *et seq.*

fact that the invaders came from lands whose geological constitution was precisely similar to that of Eastern England in respect of the all-important glacial drifts. A point which has perhaps not been emphasized however is that nowhere in northern Europe do the drifts come into contact with so considerable a mass of unrelieved clay as is provided by the London Clay. It is fair to surmise that while the Saxon invaders were familiar with every detail of topographic expression and soil character in the drift-covered tracts, the London Clay and the Chalk plateau were unfamiliar terrains. Both its past history and its physical characters marked the drift region as the locale of early Saxon settlement.

A consideration of the present distribution of the settlements within the area affords but a partial and imperfect differentiation between the drift area and contiguous tracts. The unfavourable character and aspect of the London Clay country was relative, not absolute, and large parts of it became settled long before the modern well-sinker had laid the chalk under contribution to supply

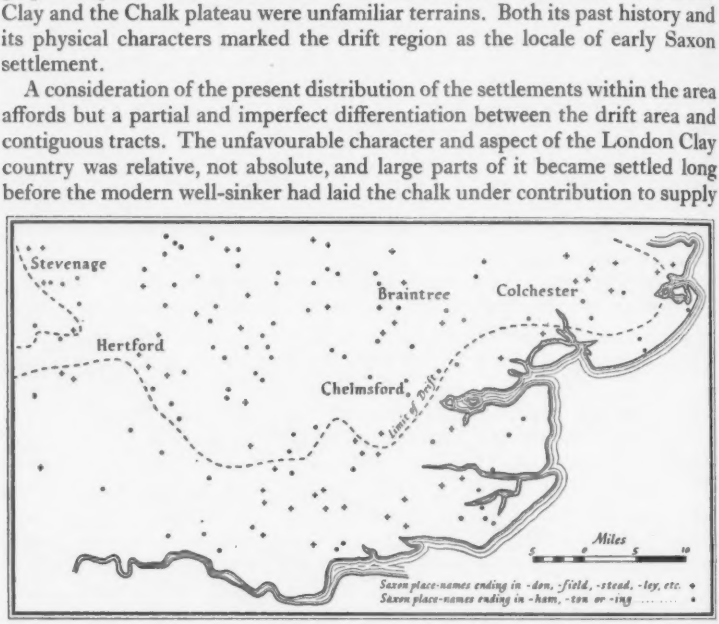


Fig. 9. Distribution of Saxon Place-names

its deficiency in underground water. This was particularly so in Essex, where it lay adjacent to the coast. We have accordingly had recourse to the place-names of the area as a means of throwing light on the early progress of the Saxon settlement. It is widely accepted by students of the subject that settlements whose name has the termination *-ham*, *-ton*, or *-ing* are earlier than those of a descriptive or topographical character, with such endings as *-don*, *-field*, *-stead*, *-ley*. Fig. 9 shows the distribution of both sets of terminations. The first is seen to be concentrated within the drift area, and notably in the west, where the boulder-clay shows its widest expanse. This is one of the few cases in which such settlements were not in river valleys. Those beyond the drift-limit lie close to it, or else are situated within the area of the Thames gravels. The London Clay area is almost without evidence of settlement at this early date. The same map (Fig. 9) also shows the distribution of the second set of terminations. As would be expected there is evidence of further settlement in the northern areas, but there is notable evidence of this presumably later phase of

settlement on the London Clay. At the risk of begging the question it may be urged that the high geographical probability of the suggested order of settlement affords some confirmation of the value of place-names in such studies as this.

From the history of Saxon days several other facts emerge of which a geographical interpretation may be given. The diocese of London constituted at the beginning of the seventh century in the charge of Mellitus excludes from its limits a large part of the true Chiltern country. From the 'Tribal Hidage,' a document assigned to the same period, we learn of the existence of a tribe—the Chilternsaeta—who inhabited this country which there is every reason to think was still thickly wooded. These people are believed to have been of British origin, a supposition supported by the high degree of nigrescence in the present population.* The main interest of the matter in the present connection is the strong suggestion conveyed that Saxon settlement was concentrated upon if not almost confined to the eastern drift plateau, while some element of the former population lingered in the wooded Chiltern country, a relatively negative area. Mackinder suggests that the isolated region of nigrescence owes its existence to its position between the extreme limits of Anglian and Saxon (Wessexian) penetration. This is no doubt true, but it seems permissible to urge as a further factor the change in the character of the country which takes place at the Offley–Preston line. Although the Wessexian and Anglian immigrations had spent their force in this area it remained open to penetration by the East Saxons except in so far as the route from the east encountered physical barriers. Although the Offley–Preston ridge is not in the narrow sense a barrier, as a limit between regions of easy and relatively difficult utilization of the soil, its importance is not to be gainsaid.

The gradual growth, conflict, and adjustment of the several Saxon and Anglian kingdoms was guided in no small degree by geographical factors, and in this phase again we perceive the influence of the Offley–Preston line. The western portion of Hertfordshire formed part of Mercia at one stage, while the eastern drift area again followed its natural geographical affinities, falling within the confines of Essex. Little is known in detail about Saxon Essex; it seems likely that it was not fully settled until after the establishment of the Angles in Suffolk. It has been contended by some that the existence of a strong fortified centre at London blocked the route up the Thames valley, and directed penetration up the smaller estuaries to the north, which, as we have seen, lead up into the heart of the drift country. All the actual Saxon remains have been found on or near the boulder-clay tract, and chiefly in its eastern or seaward portion. Beddoe† was of opinion, from the study of the present population, that a considerable British element survived in parts of Essex, chiefly, we may surmise, on the clay lands of the south. The critical area in respect of the Saxon penetration is unquestionably the watershed between the Chelmer and Roding valleys. Eastwards the valleys lead to the coast, but the country to the west is not so easily penetrated from that quarter. Hence it is likely that the immigration did not extend into the area of the Rodings, the Stort valley, and eastern Hertfordshire until a relatively late date. Nevertheless, as we have seen, the western

*Cf. Mackinder, 'Britain and British Seas,' p. 182.
†'The Races of Britain,' p. 254.

part of the boulder-clay plateau was intrinsically a more favourable area than the east, and ultimately it became more thickly settled.

The critical area of the drift margin in Hertfordshire again came into prominence during the Danish invasions, standing out as a zone of oscillating frontier or a march land. Danish influence at its maximum extent penetrated into western Hertfordshire, but the Treaty of Wedmore (878) between Alfred and Guthrum fixed the boundary of the Danelaw at the line of the river Lea from its source to its mouth. Thus the whole of the drift country was included within the Danish realm. It is of course evident that the Offley–Preston ridge, though a salient physical feature, is hardly sufficiently definite to form the basis of an actual frontier, quite apart from the fact that as a defensive line it would favour the western or Chiltern power unduly. There is no continuous or considerable stream through the Hitchin Gap, the headwaters of the Beane and the Hiz overlapping. Thus the frontier came to be fixed at the first readily demarcated line west of the true regional boundary. During the later phase of re-conquest from the Danes, when the shire system was extended, the boundary of Hertfordshire was shifted eastward across the drift country to the next marked physical line—that of the Stort–Cam depression. Essex, though it fell within the Danish realm for a long period, was not thickly settled by the Danes except in the coastal and riverine tracts and in the north on the boulder-clay. Their sojourn in the latter area set its mark upon the country and served further to emphasize the contrast with surrounding lands by the introduction of characteristic differences of land tenure, notably the extension of a class of freeman holders.

It is a striking demonstration of the cooperation of physical and historical factors that three successive waves of immigrant peoples, those of the Belgae, the Saxons, and the Danes, should have settled in the same tract and thus have served to consolidate the distinctiveness of its regional characters. It is true that each immigrant wave was guided along the same natural routeways into the country and thus tended to reach the same regional goals, but their ultimate settlement was undoubtedly conditioned by the inherent richness of the drift-lands.

A wealth of further evidence bearing upon the value and desirability of the drift-lands can be gained from the records of the Domesday Survey.* Conversely it is perhaps not too much to suggest that the interpretation of these records would gain much from an explicitly geographical basis and treatment, such as does not seem hitherto to have been accorded them.

A striking fact which emerges from the Domesday Survey of Herts is that the vills on the eastern side of the county were divided among large numbers of free tenants or small holders (socmanni) in the reign of Edward the Confessor. After the Norman invasion they became a depressed class, and much reduced in numbers, their lands being merged in the Norman manors. Their distribution in 1066 shows highly significant features, for the number falls off distinctly from east to west, and the westerly fringe of the sokelands stretched from the neighbourhood of Lilley (west of Offley) to Hoddesdon, and two-thirds of the total number of sokemen (excluding those of the Manor of

*For information upon this subject we have depended upon the Victoria County Histories for Herts and Essex (chapters on Domesday Survey by J. H. Round).

Hitchin) were to be found east of a line drawn from Royston to Hertford. The plain relation between this distribution and that of the glacial deposits as described above has not, to the best of our knowledge, been pointed out previously. Maitland's* opinion, based upon his study of the Domesday records, that this area was "richer and more populous" than the regions to the west is entirely in accord with the arguments presented in this paper, but it is probable that we see in the distribution of the sokemen no more than a legacy from the Danish occupation of the district, an occupation which, as we have already seen, was effectively limited to the drift-lands.

That Hertfordshire had for long been an arable county is evidenced by the fact that at the time of the Domesday Survey its wealth was derived mainly from the plough, though it was supplemented in order of importance by water-meadow, pasture, woodland, fisheries, and water-mills. That a transition from a pastoral to an arable country was observable in passing from south to north is also strongly suggested. Thus we read that the manors of Hoddesdon, Cheshunt, Wormley, Broxbourne, and Amwell had sufficient hay to feed all their plough teams, the two last, indeed, having an excess for sale. Thundridge and Standon, farther north, had just sufficient for feeding purposes, while Braughing had hay for only three of its teams. Other manors mentioned as having a deficiency of pasture are Westmill, Datchworth, and Digswell.

From the Essex record further interesting facts emerge. Thus it seems a legitimate inference that little pasture was yet available within the confines of the London Clay forests, for the very considerable number of sheep in the county, estimated roughly at the time of the survey as 18,000, were grazed chiefly on the coastal marsh strips, at Southminster, Burnham, Dengie, etc., and the associated cheese making was also centred on the marsh lands. Many inland parishes had pasturage rights on the marshes, and tracts such as Foulness Island and Canvey Island were broken into a patchwork of pasturage divisions attached to inland parishes.

Some idea of the distribution of forest can also be gained. The south-west of the country was thickly wooded and a wide belt of woodland stretched southward from Ongar to Brentwood. The manors particularly mentioned as being rich in woodland are Blackmore, Mountnessing, Hutton, Little Warley, Bulphan, Orsett, and Cranham. A belt of woodland stretched southward from near Hatfield Peverel to Woodham Ferrers and hence south-eastwards to Purleigh and Latchingdon. In the north of the county in the Hundred of Hinckford woodland is recorded as scarce. Thus the fact is clearly brought out that the forest was located chiefly on the London Clay area. It is not however to be supposed that the boulder-clay area was devoid of forest, for parts of it are specifically mentioned as having a large extent of woodland. There is however a suggestion that its amount decreased from the south to north, and one is tempted to correlate this with the increasingly chalky character of the boulder-clay in this direction. Considerable areas of woodland were cleared in Essex between 1066 and 1086, no doubt in large part for purposes of cultivation. There are definite references in the early charters of Essex and other areas to "assarts" or clearings for cultivation. It is significant that in Essex the

*'Domesday Book and Beyond,' pp. 22–23.

greatest clearing took place at Takely, Ugley, Thaxted, Wimbish, Notley, etc., all situated on the boulder-clay terrain.

Turning lastly to the distribution of the manors noted in the Domesday Survey (Fig. 10) we at once perceive a notable concentration in north-western Essex and eastern Herts. In Herts the maximum concentration occurs within a rectangle whose four corners are marked by Hitchin, Hertford, Bishops Stortford, and Barkway. Within this area they occur on the level boulder-clay surface, often occupying the sites of what are to-day plateau settlements. South of the line Hertford–Much Hadham–Bishops Stortford, where the boulder-clay sheet is broken by the valleys of the Rib, the Ash, and the Stort, there is a marked falling off in the number of manors, which are here situated in the valleys well above the flood plain. Within the area of the Chiltern plateau manors are relatively few. They occurred almost exclusively in the valleys, the broad clay-capped interfluves being almost devoid of evidence of settlement.

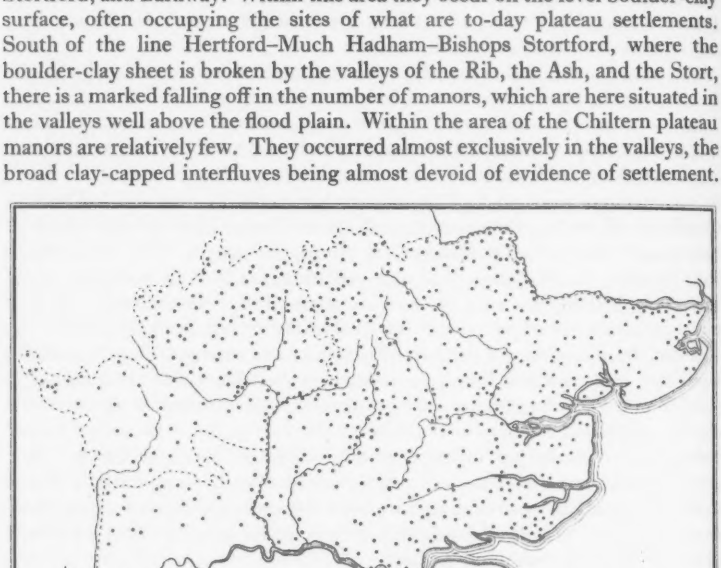


Fig. 10. Distribution of Manors noted in the Domesday Book

The Vale of St. Albans has two parallel lines of manors along its northern and southern margins respectively. Except for one at London Colney there were no manors in the centre of the Vale.

In Essex the area of the Thames gravels is thickly covered with manors, but the London Clay belt in the west shows but a sparse distribution. Farther east in the area north of the Crouch and between the Blackwater and Colne estuaries, the London Clay area, here adjacent to the coast and penetrated not only by the major estuaries but by innumerable smaller creeks, was thickly settled. There is a marked difference between the eastern and western portions of the boulder-clay tract in respect of the distribution of manors. In the east they follow the valley ways, avoiding on the whole the interfluve areas. In the west beyond the Chelmer valley we encounter the eastern side of the densely settled district already noted in Hertfordshire. The broad belt of manors which extends thence southward down the Roding valley indicates some northward penetra-

tion of the area along this route. The map also suggests the importance of the Lea and its many branching headstream system of waterways as a means of access to the thickly settled district. We may recall that the Roman road to Braughing crossed the difficult high and dissected country west of the Lea valley, but in later days the main waterway artery had attracted settlement down to the broad gravel and loam-covered valley floor and doubtless led to the founding of the modern roadway which follows the valley line. Braughing was the "Hertford–Ware" of the Roman system in a day before water-transport had come into its own.

Concerning mediaeval and modern times little need be said here. While the superior value of the drift-lands continued to operate as a factor, the social and economic history of the region shows the working of so many other factors that it is no easy matter to separate the geographical and the political elements of the problem. And the subject certainly demands more detailed treatment than we can accord to it here. In particular the growth of London as a true regional capital has transformed the regional setting almost beyond recognition, dominating and obliterating local markets and enhancing the value of the London Clay lands surrounding the capital. It is however interesting to note that in the thirteenth and fourteenth centuries when the average price of land in Herts was about fourpence per acre, higher prices, up to sixpence and more, ruled in the boulder-clay area, the zone of high prices extending from Langley to Sawbridgeworth.

It is also significant that of the smaller settlements which rose to local dominance as market towns, a large proportion lie on or near the drift boundary, and are thus situated in the zone of transition between essentially contrasted regions. We may instance Hitchin, Hertford and Ware, Ongar, Chelmsford, Witham, Maldon, and Colchester as examples of this class. In most cases other factors have cooperated in securing the relative advantage of the site; but the relation to the drift boundary is one of the most important features and one of the few that the sites have in common. The high degree of natural nodality of Hertford and Ware contributed to their past importance, an importance maintained in spite of mutual strife and the rivalry of London. The region so effectively integrated by the headwaters of the Lea converging on these towns had during past centuries and still retains in some measure the status of a separate sub-region, one of high farming and closely associated with the malting industry. The urban group at the western end of the Vale of St. Albans, comprising chiefly Watford and Rickmansworth, is closely analogous in position so far as the morphology of its site is concerned; but shows considerable contrasts in history and present development. These are largely due to the relative poverty of the surrounding country in respect of soil. As a consequence of this and of the easier access to London, Watford and Rickmansworth do not possess the character and atmosphere of local centres so strongly as Hertford and Ware, and the shadow of the Metropolis has fallen more heavily upon them.

In conclusion, we wish to thank Professor L. Rodwell Jones and Professor J. F. Unstead for reading the foregoing paper and making various helpful suggestions. Our cordial thanks are also due to Miss A. Hoffman for her invaluable assistance in preparing illustrations.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: Dr. Wooldridge and Mr. Smetham, the authors of the paper submitted this afternoon, are lecturers in geology and geography at King's College, University of London. I call upon Dr. Wooldridge.

Dr. Wooldridge then read extracts from the paper printed above, and a discussion followed.

Professor C. B. FAWCETT: I should like to congratulate the authors of the paper and the Society upon such a careful and fully detailed study in the regional geography of this country: a study of the type needed if we are going to arrive at a complete knowledge of the geography of any important area. Up to the present, as Dr. Wooldridge said, a great deal of geographical study has been concerned with wide general views in an attempt to survey a very large part of the Earth's surface at once, and it is high time that many of those wide general views were checked by these careful, I might almost say minute, detailed studies of particular areas. We have here a series of studies of just one particular contrast: types of soil within an area which has been settled for agricultural purposes for a long time and for which there is a good deal of evidence on record; and we get evidence of the very close relation of the soil features in this case to the distribution of the people on that area through the whole of the period to which Dr. Wooldridge has referred. Such distributions as those illustrated by the maps shown on the screen are, perhaps, rather difficult for those who have no detailed knowledge of the area to follow. I should like to suggest that in the further presentation of the paper there might be added some illustrations, possibly photographs, depicting typical views in the region; such views would undoubtedly make it very much easier for many to follow the study which has been set forth, and perhaps to find analogies in other regions.

Dr. Wooldridge was good enough to mention one reference to the region which I made as part of a somewhat wider study, and I may say the change to which he referred was in my own case based not on any study of the soils but wholly on a study of population distribution at different periods; and the fact that it is related closely to the line he has drawn is, I think, still further evidence that he has got a line which has been a real mark in the human occupation of the London Basin.

The PRESIDENT: I now call on Mr. Morris, Lecturer at the Working Men's College, Camden Town.

Mr. MORRIS: I have listened to Dr. Wooldridge's paper with extreme interest, and more especially to the latter part in which he dealt with the effect upon historical movements and upon settlement in the region which he has described to us. He has shown how at various periods the varying topography and the soils have affected that settlement and the utilization of the land. It seems to me that that is a piece of work which needs to be extended very widely into, one might say, almost the whole of the country. Our knowledge of the early settlement of England is scanty. We have only the very broadest outlines. In many respects our actual documentary knowledge of the early Saxon settlement is limited to some four historical manuscripts in which it is difficult to distinguish history from legend. Archaeology aids us to some extent by its findings, but the findings of archaeology are apt to be in the nature of flukes and chances, and it always seems to me that it is difficult to base any very definite conclusions upon local finds. But it seems too that geography studied in this light may be able to throw more light upon the way in which settlement by the Anglo-Saxons, and perhaps by later people such as the Danes, actually took place. Perhaps no definite conclusion can be reached even there. There is always the unknown human factor.

But we may perhaps say that a certain type of country offers a more favourable approach for settlement, and it does seem to me worth while that we should study the country in that light and see if the physical geography of a region can give any suggestion as to exactly how the settlement of any region was carried out. I think there is a good deal of work to be done along those lines and that geography can aid the elucidation of our early history along the lines which Dr. Wooldridge and Mr. Smetham have attempted.

Dr. Wooldridge referred to one interesting point in regard to the freehold tenure in the boulder-clay lands where the Danes are known to have settled. Here perhaps I am rushing in where angels fear to tread, but it seems to me that there are two possibilities there. The Danes may have deliberately seized upon the better cultivated lands. But another possibility offers itself. I think it is regarded as certain that the original Anglo-Saxon settler was a free man, a freeholder, but owing to various causes, some economic, his position degenerated. Now at the time of the Norman Conquest the majority of the Anglo-Saxon population was coming into some kind of villeinage, a semi-servile relation to the landlords. It seems to me possible that in this case, in which there were still Anglo-Saxons left upon the boulder-clay area of western Essex as well as in western Hertfordshire, where no boulder-clay and therefore the less fertile soil existed, those who possessed the most fertile soils had succeeded in retaining their economic independence longer than those who were in possession of the worst or, we will say, the less good soils of the region.

Those are the only points I have to raise, but I must say as one who is particularly interested in the problems of historical geography that Dr. Wooldridge and Mr. Smetham's paper is deserving of a very cordial reception by all those who are interested in the subject.

Mr. H. F. J. Burgess: I should like to commend Dr. Wooldridge on the clearness of his exposition, and hope he will take the criticism I am going to make in the friendly spirit in which it is offered. I cannot help remarking that Dr. Wooldridge adopts a quite modern pronunciation which possibly may have led him astray. The period of the time of Julius Caesar was more than 1200 years before the time mentioned by Dr. Wooldridge on his map. That is a long time. At that time the Saxon pronunciation of consonants and vowels was almost identical with the pronunciation of Latin by the Romans. There is no doubt that modern pronunciation of Latin is a convenience to suit our language, but if the authors of the paper, with their vast knowledge, would try to arrive at the pronunciation in vogue at the period with which they are dealing, they will probably find a great deal more light thrown on the subject.

As to the question of freehold tenure, the holding of things by law was introduced, to a large extent, by the Normans at the Conquest. Julius Caesar came a thousand years before the Conquest: he put into operation a series of controls that were hitherto unknown. He was used, with his Roman officers, to order and control people. The people, on the other hand, did not like those controls. They were very primitive. When the Romans came they were amused by the rude customs of the tribes. London was not in existence. The red cliff—Ratcliffe—was all surrounded by marshes; but that was the reason for London coming into existence: it was the one place where the Thames could be crossed. Boudicca (as the Romans called her) had no use for London. The capital of Norfolk was not Norwich, but a place thirty miles to the west. There was no such place as Norwich until after the Romans came. The freehold system was then unknown; it is a modern growth. Savage, semi-savage, or uncivilized tribes did not attach themselves to a particular piece of soil and call it "freehold"; they took land, grew their crops, left the land, and came back to it later. They had no use

for a freehold system. The assumption that they had such a system imports into the system as it existed something which was never there. If Dr. Wooldridge will study the subject in the way I suggest he will come to the conclusion he desires and find a great deal more light thrown on the matter.

Dr. L. DUDLEY STAMP: It really was not my intention to speak this afternoon because I returned from the West Indies very late last night and have not had an opportunity of reading the paper. But the lucid account Dr. Wooldridge has given has proved so interesting that I feel I must add my tribute to those already paid to the value of the paper, more especially, as Professor Fawcett said, as a specimen of the type of work so badly needed in all parts of this country. From that point of view there is one question I would like to put to the authors. I feel sure that the paper will be taken as a model by others working elsewhere in Britain. We have heard stressed this afternoon the control exercised by soil, and I would like Dr. Wooldridge, if possible, to add that which I think is not perhaps fully detailed in the paper as it stands: the essential characteristics of the soils. The reason for that is this: that, as I see it, the boulder-clay of the area with which the paper deals is exceptionally favourable from the economic point of view, largely, I believe, because it is a chalky boulder-clay in which the element of lime comes in and makes the soil of great value. On the other hand, I think it quite likely that in other parts of the country boulder-clay of a different character would exercise an entirely different control, and therefore that the specific characters of the boulder-clay soil of the area under discussion should be detailed. I hope it will be possible for Dr. Wooldridge to do this in his very valuable paper.

Sir HALFORD MACKINDER: I have not had an opportunity of reading the paper beforehand and I am not therefore going to venture on any criticism of it. The method which you have had exemplified is the method which is now being followed in the University schools of geography in this country and in a number of other countries. It was the method which we had in view when we founded more than thirty years ago the Oxford school of geography, the first in Great Britain. It is a strictly geographical method because it is based on the comparison of maps. At the time I speak of, though we foresaw the method, we had not a body of young geographers properly trained to apply it, but as there are to-day a number here present who are now well qualified, may I venture to say a word or two in regard to it?

It seems to me that there is a little danger that we should mix history with geography without seeing clearly what we are doing. Geology is a part of history, and I think we ought to remember all the time that geography proper is a description of things in the present. Geography should, as I see it, be a physiological and anatomical study rather than a study in development. As its name implies, it should be a description, with causal relations in a dynamic rather than genetic sense. But there is a true historical geography, a study of the *historical present*, an idea and expression familiar to all literary folk. In that case the geographer has to try and put himself back into the present that existed, let us say, one thousand or two thousand years ago; he has got to think of the geography of that time complete; he has to try and restore it. In the geography of to-day are undoubtedly a number of remnants of such past geographies, but that fact should not alter the whole perspective of the main subject.

To a person who is about to be operated upon for appendicitis the history of the development of the appendix and of its degradation from an old function is not as a rule of much interest. The London of to-day is a vast organ in the anatomy and physiology of the Earth's surface, a deposit of several million human beings, interrelated in the most vital and complex ways with one another

and with the soil on which they are placed. The geographer has to appreciate and weigh that great fact. The characteristics of the little hills, and marshes, and bits of forest upon and amid which the original village or villages were placed out of which London has developed are a totally different matter. Let us keep the two inquiries apart.

What I would like to impress upon the younger men and women who are taking up what we older men have tried to hand on to them is that if geography is to win an assured place as one of the great branches of knowledge, respected by those who are following other branches, then we must distinguish between speculation and ascertained truth. Speculate—it is of the very essence of advance. Let us have speculation based on your comparison of maps, but do let us try to put on record, as the result of criticism among ourselves, a body of tested and accepted knowledge.

It seems to me that we have now reached a time when possibly there might be formed some circle of students, say within this Society, who would build up a philosophical geography, originated by observation and speculation no doubt, but tested by criticism. There are many essays in existence, some penetrating and some superficial, some published and some not, but they are individual effusions. What we need is debate on particular problems, pushed to the point of establishing or destroying particular theses, and so we may build up a body of really philosophical geography.

The PRESIDENT: The lecturer need not have apologized, as he did at the outset, for mentioning his subject, for he may be assured, and others also, of a cordial welcome in this hall when he puts forward what is commonly known as regional geography. We do not spend all our time in chasing about after new places in the world. Dr. Wooldridge has given us a most interesting afternoon. He has covered a great deal of ground, and covered it very minutely. It would be foolish of me to pretend that I have an expert knowledge of the subject, so that it is not altogether easy to follow the correlation. When the paper is produced I suggest to Dr. Wooldridge, as I have to many others who follow expert subjects, that I hope it will be so clearly worded that not only those who are already experts will be able to grasp fully all that is meant, but that all will be able to form some idea of his meaning. I made certain notes as the lecture proceeded. Some mention was made of the way in which agriculture followed the soils. What part of London did people go to? What was it that took them there? Is it worth while following what happens in other lands? You see people sometimes driven by force of arms from one place to another, but they search at the beginning for a place where they can cultivate the ground undisturbed. After that come industries and matters of that kind. If you follow the Dutch in South Africa where they moved on and on, that is always what they went for.

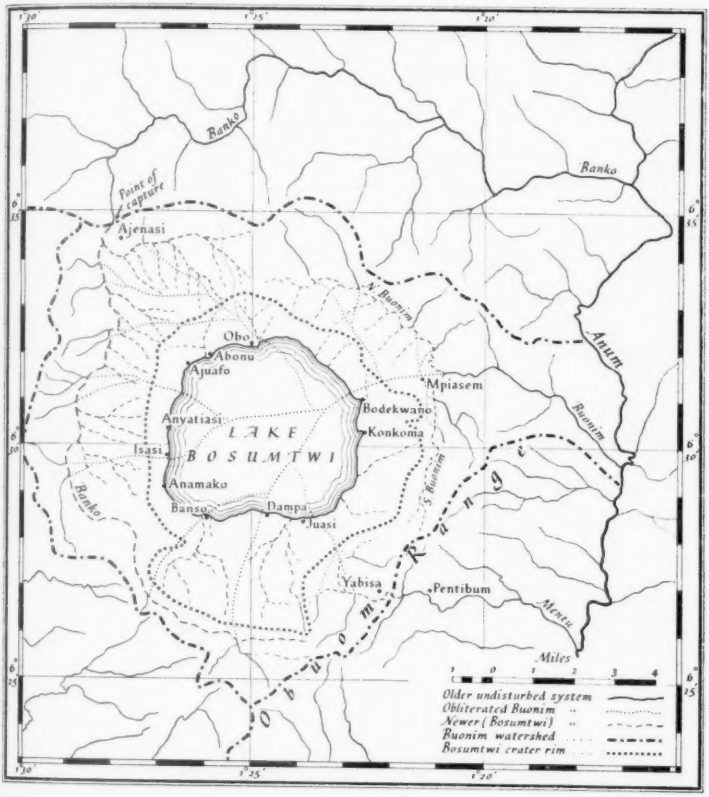
It seems to me that all such studies of the past as Dr. Wooldridge and Mr. Smetham and many others are making are of very great value to the future. One looks to the past for lessons and to the future for ideas. With that, ladies and gentlemen, on your behalf and on behalf of the Society I will ask Dr. Wooldridge and Mr. Smetham to accept our thanks for a most interesting lecture and discussion.

LAKE BOSUMTWI, ASHANTI

MALCOLM MACLAREN, D.SC., F.G.S.

LAKE BOSUMTWI lies about 20 miles south-east of Kumasi, in lat. 6° 30′ N. and long. 1° 25′ W. Lakes are rare topographical phenomena in tropical West Africa. None other than Bosumtwi is known in the Gold Coast Colony. The nearest are the Timbuktu lakes (Debo and Faquibine), 700 miles to the north, a small lake (Iyede), 500 miles to the east in Southern Nigeria, and Lake Chad, 1050 miles away to the north-east. All these latter, and a few others of trifling size, are merely phases of development of the Niger or of the Shari river-beds. Unlike them however Bosumtwi does not lie in the channel, present or ancient, of any river; it is not only situated high up on the watershed between the Anum and the Adra branch of the Ofin, the Anum and the Ofin being the two main tributaries of the Prah River, but its waters are also self-contained and are wholly isolated from the general drainage system of southern Ashanti. The general altitude of the feebly dissected upland in which Bosumtwi lies is about 950 feet above sea-level. This upland extends far to the north and to the south, and its general level is broken only by the 3 mile wide north-east to south-west striking Obuom Range, of an average height of 1600 feet above sea-level, and with two peaks reaching heights of 1775 feet and 2225 feet respectively. Both upland and range are densely forest clad. The Obuom Range forms part of the great "gold belt" of the Gold Coast Colony, and, 30 miles to the south-west, it contains the famous Obuasi gold mine of the Ashanti Goldfields Corporation.

Lake Bosumtwi is roughly circular, with an average diameter of a little under 5 miles. It lies at the bottom of a great crater with its surface waters 900 to 1200 feet below the crater rim. The diameter of the crater at the rim is about 6½ miles. The inner slopes are steep. They were obviously originally precipitous, but have been modified somewhat by denudation. The western wall, for example, is now the steeper, owing to the westerly dip of the phyllites that form the greater portion of the crater walls. On the western side two distinct slopes are observable, an upper of about 30°, and a lower of 10°, the latter formed of talus from the upper slopes. The inner walls of the crater are densely jungle clad. Perhaps the most striking topographical feature is the continuous and unbroken rim, which is raised from 300 to 600 feet above the general upland level (950 feet). The outer slopes of the rim are gentle and merge gradually into the normal upland topography. The water-gathering area of Lake Bosumtwi is therefore confined wholly to the crater walls, and no stream flowing into it has a greater length than 2½ miles, while the majority have lengths of about a mile. The maximum depth of the lake appears to be at the present time about 240 feet, so far as may be gathered from the few soundings. The bottom of the lake is therefore 100 feet above sea-level. The depth of the crater from the lowest portion of the rim to the bed of the lake is 1150 feet. It is probably no coincidence that this is exactly the depth to solid rock given for the famous Meteor Crater in Arizona. A general inspection of the soundings indicates that over an area of 5 to 6 square miles the central portion of the lake is fairly flat. It commences to shallow only about a mile from the shore, except in the



Older and Newer Drainage Systems of the Lake Bosumtwi district, Ashanti

UNIV. OF MICH.

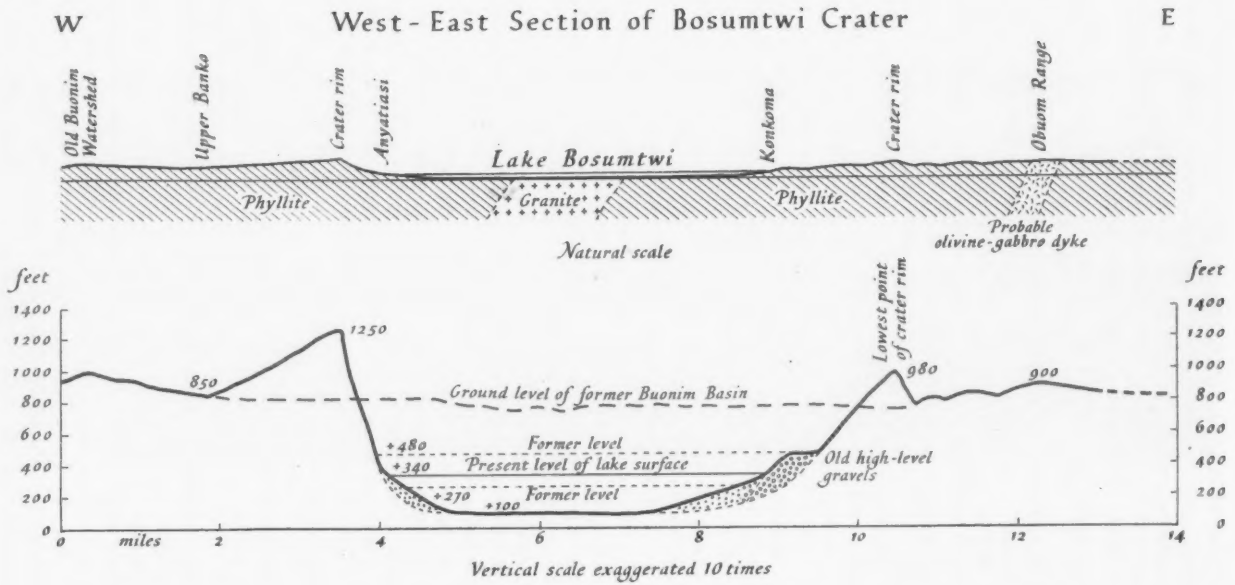
Lake Bosumtwi, Ashanti

southern end of the lake, where the two largest streams of the Bosumtwi system have naturally brought down a greater quantity of sediment than has been possible elsewhere. The bottom of the lake beyond the reach of the sediments of the tributary streams is formed of decomposed vegetable matter, mainly from the reeds that fringe the shores of the lake.

Various explanations have been advanced to account for the origin of Lake Bosumtwi. The layman, impressed by its steep sides and its undoubted crateriform character, has decided to his own satisfaction that it occupies a volcanic crater. But its rocks, and those of the surrounding country, are the normal phyllites and granites of the Birrimian (Pre-Cambrian) series of the Gold Coast Geological Survey. There is nowhere in the neighbourhood any trace of volcanic ejecta, either of lava or of ashes. The only direction in which the Bosumtwi crater could be linked with volcanic phenomena is by way of a volcanic gas-eruption, and such gas eruptions have never been recorded outside already existing volcanic areas. The very recent origin of the crater is definitely proved by its isolation from the general drainage system of the country, and no evidence of recent (post-Pleistocene) volcanic action is recorded elsewhere in the Gold Coast Colony. Nor in the steeply dipping pre-Cambrian phyllites is there any possibility of an accumulation under pressure of natural gas (hydrocarbon) such as have, within the writer's experience in Transylvania, blown craters 200 yards in diameter in horizontal strata. Further, there is on the rim of the crater no evidence whatever of any fragments, large or small, of the phyllites or granite. In the half-dozen widely separated spots where the rocks of the rim could be examined they showed the normal north-north-east to north-east strike with an invariable steep westerly dip. The rim is emphatically not composed of débris. The assumption of a crater formed by an internal gas explosion must therefore be dismissed.

The Gold Coast Geological Survey some years ago very tentatively suggested a theory of basin subsidence controlled by intersecting faults or pairs of faults. Modern faults, such as are here postulated, are however extremely improbable in these stable pre-Cambrian areas. To the geographer, moreover, the outstanding feature of Bosumtwi crater is its recent origin, and the trace of any such impressive modern faults, with a downthrow of 1150 feet, must necessarily have been preserved by surface escarpments, and of these there is no sign. For the same reason no theory of rift origin is possible. Nor is any theory of *dolina* origin admissible. The rocks of the crater are insoluble phyllites and granites without trace of limestone or dolomite. It is true that farther south-west at Obuasi similar phyllites are highly carbonated, but that carbonate (calcite, dolomite, and ankerite) is purely local and lies on either side of auriferous lode-channels. No gold is known in the immediate neighbourhood of Bosumtwi. In any case any theory of formation by actual subsidence fails to account for the unbroken raised crater rim.

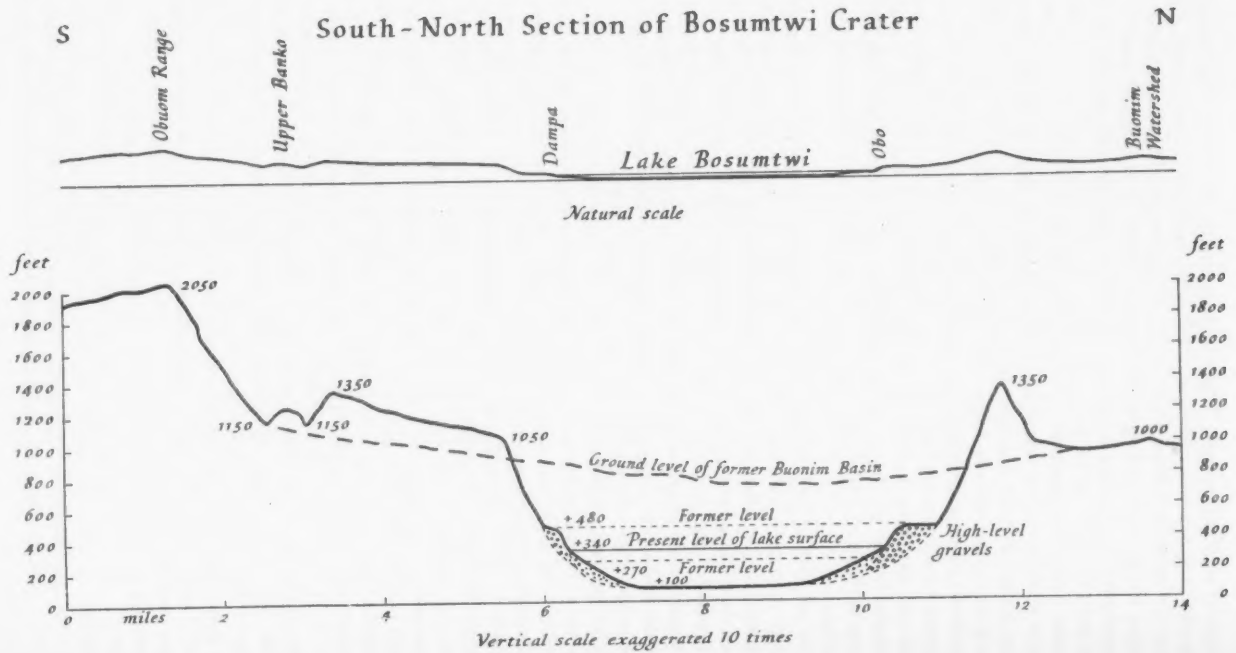
A satisfactory theory of origin for the Bosumtwi crater must account both for its recent origin and for its solid, practically undisturbed raised crater rim. Possibly, and indeed preferably, it should also account for the height of the surface waters of the lake, 900 feet below the rim, though that may be, and probably is, a wholly separable problem. The only genetic theory that appears to fit all the observed facts (with the exception of the last-mentioned) is that of


W
West - East Section of Bosumtwi Crater
E
Old Buonim Watershed
Upper Banko
Crater rim
Anyatiasi
Lake Bosumtwi
Konkoma
Crater rim
Obuom Range
Phyllite
Granite
Phyllite
Probable olivine-gabbro dyke
Natural scale
feet
1400
1200
1000
800
600
400
200
0
850
1250
Ground level of former Buonim Basin
Lowest point of crater rim
980
900
+480
Former level
+340
Present level of lake surface
Old high-level gravels
+270
+100
Former level
0
miles
2
4
6
8
10
12
14
Vertical scale exaggerated 10 times

origin by meteoric impact. There is no reason to assume that the diameter of the meteor in any way approached that of the resultant impact-crater. Travelling, as it must have done, at a velocity of approximately 50 miles per second, urging ahead of it, and especially drawing behind it, enormous quantities of superheated air, the shock and heat of impact must have blown all rock round the point of impact to incandescent dust. If, as was probable, since by far the greater number of meteorites that enter the Earth's atmosphere are stony and not of nickel-iron, the Bosumtwi meteor was stony, then it also was blown to dust, leaving in solid masses only the small portions of nickel-iron metal that stony meteorites usually carry. The mass of the meteor is probably to be expressed in thousands rather than in millions of tons, and the relative diameters of meteor and crater are believed to be comparable to those of a high-explosive shell and the crater formed by it. The direction of the meteor is possibly indicated by the greater piling up of the rim against the flank of the Obuom Range to the south. If this assumption is valid the meteor fell from the north-north-east.

No meteorites have yet been recorded from the vicinity of Lake Bosumtwi, though they were reported from native sources to have been picked up some fifty years ago at Anamako, on the south-west shore of the lake. On inquiry there, the old headman, possibly for good and sufficient "juju" reasons, denied all knowledge of such stones. Caution is however always necessary in accepting from native sources stories of "stones that fell from the sky," since the Ashanti includes under that category the stone axes and celts of a race of inhabitants that occupied the country prior to the Ashanti invasion.

A few magnetic observations for aberrations in declination, inclination, and intensity (κ) were made with a prismatic compass and a dip-compass. These however were too few to possess any real value. So far as the observations for declination went no material aberrations were noted. The more delicate dip-compass however showed a series of variations, both in inclination and in magnetic intensity, compatible with the existence of a magnetic body in the lake north-east and south-east of the village of Isasi, on the south-west shore. Observations, carried from Dampa in the south-east corner of the lake to Ajuafo in the north-west corner, there indicated a zero point. But the writer is disposed to place very little reliance on these few observations, since the dip-compass, with a sensitivity only to forces greater than 2000 units (of $1 \cdot 10^{-6}$ C.G.S.) is too weak to respond to distant attractions. Further, reliable observations cannot be made from the lake shore; traverses and cross-traverses of the lake are essential to obtain the isogonic, isoclinic, and isodynamic contours that any concealed magnetic body or bodies would furnish. With a very large magnetic body, such as the whole mass of the meteor were it composed of nickel-iron, the dip-compass would of course be sufficiently sensitive to give positive results, but with the smaller body or bodies to be expected a magnetometer of the Thalén or Tiberg-Dahlblom type (sensitivity, 200 units) would be desirable. A magnetic field balance of the Adolf Schmidt type (sensitivity, 5 units) as used in modern geophysical surveys, besides being cumbrous and extremely expensive, would probably prove unduly sensitive for the purpose in view, especially when used on an unstable platform on the lake surface.


S
South-North Section of Bosumtwi Crater
N
Obuom Range
Upper Banko
Dampa
Lake Bosumtwi
Obo
Buonim Watershed
Natural scale
feet
2000
1800
1600
1400
1200
1000
800
600
400
200
0
2050
1350
1150
1150
1050
1350
1000
Ground level of former Buonim Basin
+480 Former level
+340 Present level of lake surface
+270 Former level
+100
High-level gravels
0 miles 2 4 6 8 10 12 14
Vertical scale exaggerated 10 times

The accompanying skeleton sketch-map shows the pertinent drainage systems. The Buonim drainage system has obviously been greatly affected by the formation of the Bosumtwi crater, while the Banko and, to a much lesser extent, the Mentu have received accessions to their volume as a result of the disturbance of the upper Buonim basin. The old Buonim watershed remained undisturbed and its former stream system is diagrammatically shown on the sketch-map by dotted lines, with the self-contained Lake Bosumtwi system superimposed on it. Apart from the latter, the principal changes appear to have been the following. The stagnant waters penned between the western rim of the crater and the original western watershed of the Buonim have been captured by a small tributary of the Banko at a point about ½ mile west of Ajenasi village. The length of the Banko stream has thus been extended by some 10 miles. The mountain streams that formerly flowed into the Buonim basin from Yabisa on the crest of the Obuom Range have been reversed by the uplift of the crater rim and have formed a deep gorge between Yabisa and Pentibum, through the range, and now join the Mentu system. Two other large streams, developed as a result of the crater rim uplift, are the two main tributaries of the Buonim which join the lower Buonim at Mpiasem.

Some consideration must be given to the probably separate problem of the level of the waters of the lake. The surface of the lake is to-day 340 feet above sea-level, and it has been rising at the rate of 1 foot per annum for at least seventy years. The lake edges are dotted with gaunt trunks of giant cottonwood trees killed by the rise of the waters. Within the memory of the older inhabitants, all the villages on the shores have been moved, some of them four times, to successively higher levels. An ancient high-level gravel terrace, naturally developed to the greatest extent at the mouth of the largest streams (Banso and Juasi), occurs at 140 feet above the present lake level (or 480 feet above sea-level). Judging from the great development of this terrace, the waters of the lake were held at that level over a very long period of time, and, from the deep, narrow, almost vertical-sided ravines since cut by streams in the gravel, it would appear that the fall of the lake waters from 480 to 270 feet above sea-level was very recent, and was sudden and catastrophic in character. The waters of the lake are perfectly fresh. The rainfall of the district is about 65 inches per annum. Except for the three months (January to March) when the harmattan is blowing the difference between wet- and dry-bulb temperatures is negligible. Evaporation is therefore at a minimum for the greater part of the year. The area of the Bosumtwi drainage system is roughly 2¼ times that of the lake. With a rainfall of 65 inches per annum and allowing a 100 per cent. "run-off," owing to the great depth of the lake below its catchment area, the evaporation must reach at least 11 feet per annum to allow for an annual rise of 1 foot. With the prevailing humidity any such amount of evaporation is highly improbable. A total of 4 feet is much more likely under Bosumtwi conditions. This consideration, and that of the freshness of the lake waters, therefore suggest a subterranean exit for Bosumtwi waters. But one must go 50 miles away down the Prah River before a point on the surface 250 feet above sea-level is reached! A résumé of the geology of the lake may be of assistance here. The rocks are phyllites (quartz-sericite schist) striking north-north-east and south-south-west, and dipping westward at steep angles. A single

broad dyke of granite of similar strike and presumably similar dip passes down the middle of the lake. In pre-Cambrian times the phyllites have been overfolded to the east with the consequent development of great overthrust faults and still later shear-faults, both striking with the country, but the former dipping 35°–40°, and the latter 80°–85°, in both cases to the west. These fault-planes, from analogy with Obuasi, further south-west, where they have been followed down to depths of 2500 feet, are the water-channels of the country. It has already been stated that soluble rocks that might form underground channels are unknown.

Research in the Bosumtwi area is highly desirable. A complete magnetic survey of the lake is indicated, and a search for small meteorites, for a distance of at least 6 miles from the crater rim, is also advisable. The whole country is covered by a dense tropical forest through which a way may be made only by laborious use of the machete. The best fields of search for such meteorites are therefore the stream beds of the upper Banko, of the lower Buonim, and of the Mentu. Definite and successful results, either from the magnetic survey or from the search for small meteorites, will, in the opinion of the writer, at once establish the origin of Bosumtwi crater by meteoric impact. Unfortunately, from a scientific point of view, negative results will not destroy that theory, since the meteorite may have been wholly stony. The points of capture of the Upper Banko and of the Upper Mentu should be examined; the examination of the gorge of the latter may be especially helpful. And finally there is the problem of the surface-level of Lake Bosumtwi. The discrepancy between precipitation and evaporation may indeed be balanced by proving a lesser "run-off" and a higher evaporation.

Lake Bosumtwi has always, in the short history of Ashanti, been a "sacred lake," with numerous tabus. Its waters teem with small fish, and the origin of the tabus is clearly economic, to prevent the valuable monopoly of the fishing shore-dwellers being wrested from them by interlopers. The principal fishing tabus are against (1) baits, lures, lines, or iron hooks; (2) casting nets; (3) seine nets; (4) canoes, boats, sails, paddles, or poles; (5) brass or metal pans; (6) fishing on Sundays (that being the day of the Bosumtwi lake deity). The only method of locomotion on the lake, other than swimming, is by means of shaped and pointed narrow logs (*mpadua*), on which the fisherman lies face downward and propels himself with his arms, using his feet as rudders. Fish are taken by driving them into fixed nets made of woven reeds. Within the last five years some at least of these tabus have fallen into desuetude. Casting nets, twine seines, hooks, lines, and baits, and metal pans are now freely used, and there would probably be little difficulty in obtaining permission to use a copper-fastened boat, collapsible or otherwise, for the purpose of a magnetic survey.

The foregoing has been written beyond the reach of any books of reference, and is moreover based on two short visits of a few hours each. It is to be regarded merely as indicating an interesting field of geographical research on the shores of one of the most beautiful lakes in the world. The literature of Bosumtwi Lake is decidedly scanty. The only description of it and of its people known to the writer is contained in pp. 54–76 of 'Ashanti,' by Captain R. S. Rattray (Oxford: Clarendon Press 1923).

A TRAVERSE FROM ICE FJORD TO WIJDE BAY, SPITSBERGEN

R. M. JACKSON

THE area covered by our expedition in the summer of 1930 lies between Klaas Billen Bay and Wijde Bay, together with some part of the western side of the Mount Newton system. Notes on the physiography of New Friesland and Garwood Land are to be found in the results of the Merton College (Oxford) Expedition to Spitsbergen, 1923 (*G.J.*, vol. 64, p. 195). The nomenclature adopted there is perhaps open to objection, but it seems best to adopt it provisionally.*

The sheet of highland ice on Garwood Land called the Central Ice Plateau is drained westward by two main glaciers; to the west the Nordenskiöld Glacier flows into Klaas Billen Bay, and to the north-west the Mittag-Leffler Glacier flows into East Fjord of Wijde Bay. Previous expeditions, including the pioneer journey of Sir Martin Conway and Professor Garwood, have reached the Central Ice Plateau by way of the Nordenskiöld Glacier. Alternative routes from Klaas Billen Bay are by way of the smaller Ebba Valley or Ragnar glaciers.

The crossing from Klaas Billen Bay to Wijde Bay by the Ragnar Glacier and Mittag-Leffler Glacier has been made several times by trappers, and all parts of it must have been seen from neighbouring mountains by different expeditions. Previous mapping of the area consists of a map by Vassiliyev made from the material of the Russo-Swedish Arc of Meridian Expedition of 1899 to 1901, published in 1925; but this particular region was not visited by that expedition, and the map is even in its main features far from accurate. Isachsen's general map of Spitsbergen shows no physical features of this area, and is of use only in giving a few names which are generally accepted.

The purposes of the 1930 expedition were to map the Mittag-Leffler Glacier and, as far as possible, to explore the branch glaciers entering it from the east. The area to the east and north-east of the Mittag-Leffler Glacier is one in which much further geographical and geological work remains to be done, and it seemed to be desirable to find an approach to it other than by way of the Nordenskiöld Glacier. Captain Staxrud, in his second journey northwards to relieve the Schröder-Stranz Expedition in 1913, made a rapid south-to-north traverse up the centre of New Friesland. The Oxford Expedition, starting from Duyn Pt. Hinlopen Straight, crossed the Mount Newton system, worked south and then south-west, and reached Klaas Billen Bay by coming down the Nordenskiöld Glacier. Neither of these expeditions linked up the Newton system with the Mittag-Leffler Glacier or Wijde Bay.

In many ways it might be considered more convenient to use Wijde Bay as a base, but there is always great uncertainty of being able to reach Wijde Bay by ship on account of pack-ice drifting down from the north. Klaas Billen Bay in Ice Fjord is normally quite easy of access, and was selected for this reason.

Our personnel consisted of N. W. Pirie, P. Lamartine Yates, G. C. Monkhouse, and myself—all Cambridge men. We travelled as passengers in the

*For geology of New Friesland; Odell, *Quarterly Journal of Geological Society*, 1927, vol. 83, 1.

sealer *Haakon* (captain Jens Olsen), sailing from Tromsö, and were landed in Petunia Bay, the head branch of Klaas Billen Bay, on 2 August 1930. By kind permission of the Scottish Spitsbergen Syndicate we were able to use their hut in Ebba Valley as a base. We had with us a large rowing boat, purchased in Norway, so that we could retreat down Ice Fjord at any time to the coaling station at Advent Bay. Our stores and equipment were fairly modest, and our own rowing boat with one of the sealer's boats was sufficient to transport everything ashore, the whole operation taking about half an hour. The *Haakon* left at once to continue her voyage northwards.

The Norwegian survey of Spitsbergen reaches the head of Ice Fjord and includes two mountain tops near our base; it was necessary to climb each of these as a preliminary to our own survey. The climb up Mount Hult was a laborious grind for 2500 feet up scree. The summit ridge consists in places of a wall of rotten rock, 10 or 12 feet high and 2 or 3 feet thick, steep scree slopes descending from the base of the wall on each side. The ascent to the Norwegian survey point on De Geer range gave us a certain amount of difficulty; the summit consists of hard rock over softer rock, and in most places erosion has given the final cap a pronounced overhang. The summit was not visible from our base in Ebba Valley and, as we had not had a chance of inspecting the route, we failed to take the line of least resistance. It proved pleasant as a mountaineering expedition, for of necessity we tackled a rock chimney, three short pitches of ice couloir, and an ice ridge to the summit. From the top in weather such as we had the view covers most of Central Spitsbergen. We returned to the hut after twenty-four hours of walking and climbing.

We were now in a position to begin the crossing to Wijde Bay. As a preliminary we carried stores up the Ebba Glacier to Camp 1 at 2500 feet. Most of our travelling had to be done below the snow-line at heights of less than 3000 feet, and we were forced therefore to carry all loads on our backs. We found that there was nearly always dry glacier at these low heights, and sledging over dry glacier would have been impossible. Our first journey up the Ebba Glacier on August 8 showed that this route affords a perfectly easy way to the interior. After depositing stores at Camp 1, Pirie and myself climbed the hill P 2. We had learned by now that the most efficient way of climbing thereabouts is to choose a route with as much ice on it as possible and use crampons. On the summit ridge of P 2 we found the same curious type of broken wall that we had previously found on Mount Hult. P 2 proved a useful peak for survey work, and a cairn was built on the highest point. From the summit we looked down the Mittag-Leffler Glacier, and could see nunataks invisible from Hult or the De Geer trigonometrical point. P 2 is also a point easily distinguishable when seen from the high ground to the east of the Mittag-Leffler Glacier.

We returned that night to the base, returned to Camp 1 the next day, and on the day following (August 11) marched in a northerly direction across the head of the Mittag-Leffler Glacier. The higher ice was covered by deep snow, which made load-carrying very laborious; and we were very considerably delayed as we began to descend by crevasses fronting a prominent outcrop. After a route had been found through the crevasses we left the snow and reached dry glacier, but once more we were forced to detour by a large drainage

Wordie Crags and Petunia Bay from De Geer range

Ebba Valley and glacier from Wordie Crags

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Vassiliyev's "Vallée de Martin Conwey"

Camp 2: P2 and P3 on horizon

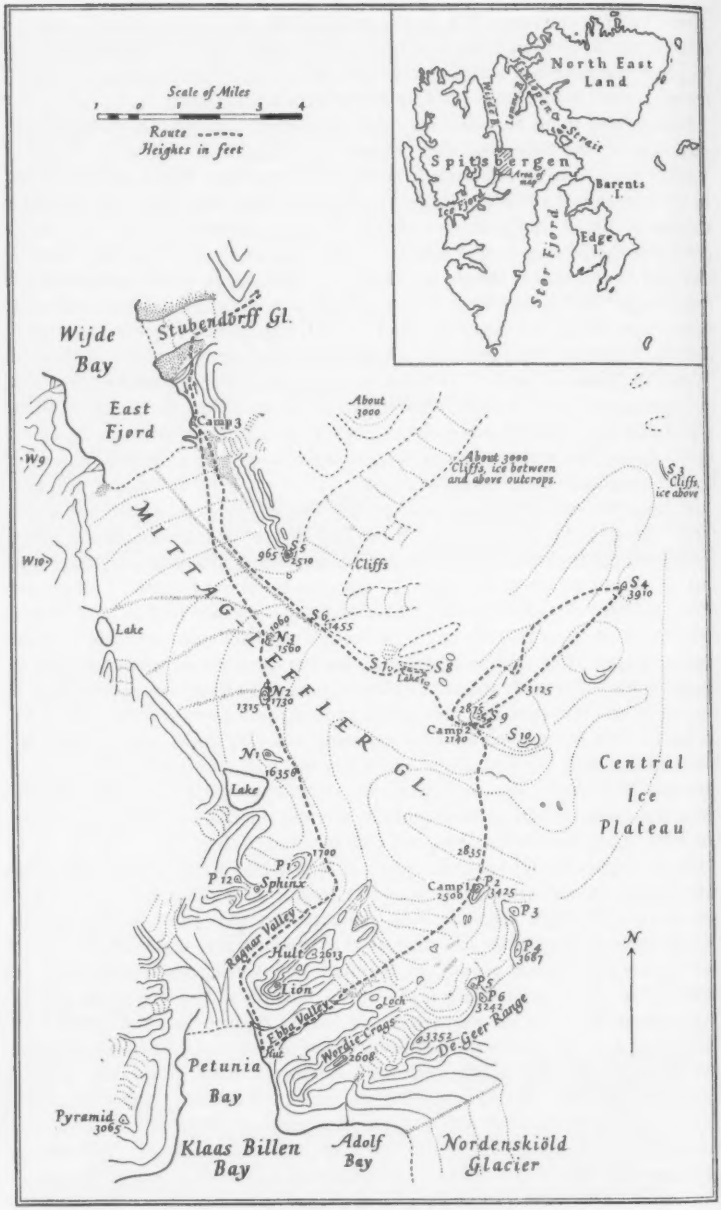
stream barring our way. We finally reached the rock outcrop and camped, although no more than 5 miles on from our previous camp. The rock outcrop by Camp 2 consists of a cliff 200 to 300 feet high. The next day was spent relaying stores from Camp 1 to Camp 2 to form a depot there.

Mist settled in in the afternoon and continued through the morning and afternoon of the following day, August 13. Since our arrival at Camp 2 Monkhouse had been suffering from digestive troubles. When the mist lifted we left him to rest while we climbed to the top of the rocks above the camp for surveying. From that point we obtained a good general idea of the higher portion of the Mittag-Leffler Glacier. Vassiliyev on the Russian map shows a rock wall on the west of the glacier, but for the east side he marks some rock and then a large "Vallée de Martin Conwey" (*sic*) sweeping in from the north-east. It was clear from our viewpoint that the Mittag-Leffler Glacier has a quite definite containing wall of rock outcrops along its eastern side, and that the "Vallée de Martin Conwey" is much narrower and bounded on its south side by intermittent cliff. Before returning to camp we followed up the southern side of that valley, past some rock outcrops, to a prominent bluff near its head; on our return down the valley we were much hindered by crevasses, and were later back to camp than we had planned.

At camp we found Monkhouse out of his sleeping-bag and apparently much better. Despite his recovery, I did not feel that he should continue farther. He himself felt that he might have a further attack, and it was decided therefore that he should return to the base. It was then midnight (August 13–14), and although three of us had already had a long day it seemed best to have a meal and start at once, so that we could be sure of well-frozen snow bridges in the crevassed area. The cold did more than harden the surface; when one man in changing his socks inadvertently left the uppers of his boots crumpled inwards they froze into that position, giving him a pleasant problem of how to get them on again. The going over hard-frozen snow was very good, and in about six hours we reached the foot of the Ebba Glacier, and wandered rather wearily through the Ebba Valley mud to the hut. We reviewed the position. Monkhouse was quite certain that he would be all right if left at the base alone whilst the three of us continued inland, and convinced us of this.

On the following day (August 15) Pirie, Lamartine Yates, and myself, with light loads, made an easy march back to Camp 2. One night was spent there, and then, with eight days' rations, we marched down the Mittag-Leffler Glacier towards Wijde Bay. During most of the day there was fairly thick fog, and the march was not productive of much new knowledge, except that we learned that this glacier has a fairly uniform slope and is free from serious crevasses up to about the point where it begins to drop into the fjord. The march that day was a comparatively long one of over 10 miles in direct distance, and we were not sorry to pitch our tent on pleasant moss by the side of East Fjord of Wijde Bay. We had passed from one type of country to another; Ebba Valley, with its stretches of mud and mountain sides of scree with little vegetation, can seem desolate, but Wijde Bay has a different character. Mosses and lichens grow freely and stretch far up the mountains, while reindeer tracks and much bird life suggest a more hospitable country.

At Wijde Bay our activities were threatened with a further breakdown.



Mr. Jackson's route across Mittag-Leffler Glacier, Spitsbergen

Pirie, who is nearly inexhaustible in walking over rough country, developed a septic heel. A portion of our oatmeal made an efficient poultice, but it was clear that he would be out of action for at least three days. His first day of rest did not hinder our plans, as we intended in any case to work round Camp 3. Lamartine Yates and myself returned to a point on the Mittag-Leffler Glacier where a tributary glacier flows in from north-east. We climbed the hills forming the eastern wall of the Mittag-Leffler Glacier, walked south along the ridge, and crossed a deep gully to the point S 5. This point may be the "Mt. Ramsey" marked on Isachsen's map. From the summit (where we built a cairn) we had a clear view of the tributary glacier; it is about a mile wide and flows down between walls of rock generally precipitous and about 1000 feet high. The gorge cuts through the middle of Vassiliyev's "Mts. Coupole de Neige." It may seem strange that such a prominent valley should have escaped notice, but the bordering cliffs are surmounted by snow, and when seen from the south, as we saw them from the point S 4 on August 13, the appearance is that of a rounded dome of snow, suggesting merely a gentle dip, down and up again, to the next dome. It is not safe to assume even a small area as snow covered unless it has been seen from opposite viewpoints. The "Vallée de Martin Conwey" is another example; when we looked across it from above Camp 2 on August 13 we did not realize the existence of big rock faces seen later when we returned down the middle of that valley.

On August 18 the weather kept us in camp, but the next day it cleared, and Lamartine Yates and myself were able to prospect part of the route up the Stubendorff Glacier. At its seaward end there is a vast lateral moraine, and this reconnaissance was extremely useful in finding an easy route on to the ice. According to Vassiliyev the valley of the Stubendorff Glacier should run inland from Wijde Bay in an easterly direction towards Mount Newton. Further examination of Pirie's heel made it clear that he could not continue until after a further rest. To spread the personnel of an expedition about Spitsbergen is hardly satisfactory, but as no harm could come to Pirie during a short stay alone at Camp 3, it was agreed that he should bivouac there under an overhanging rock whilst Lamartine Yates and myself made a short excursion towards Mount Newton.

Taking four days' rations, we proceeded up the Stubendorff Glacier on August 20. To our surprise we found that the glacier valley does not run due east as supposed by Vassiliyev; at the coast the direction is easterly, but almost immediately it changes to the north-east. We followed up the glacier for about 6 miles, to a point where it divides, the eastern arms becoming cols in a mountain chain which runs roughly north and south. The upper reaches of the glacier provided two hours' exacting work among crevasses. We were roped with a double rope, but I believe the problem of what happens if one of a party of two falls into a crevasse is insoluble; a heavy rucksack is a further complicating factor. At 3500 feet we found a small flat rock outcrop on which a camp was possible. The mountains were now much more Alpine in appearance; even a strong climbing party would, I think, have difficulty in climbing at least one or two of the peaks.

The morning of August 21 did not look promising, and we chose as our objective the one mountain, and that not the highest, which seemed to offer a

route on which we were certain to be successful. The route chosen was a fairly easy mixture of rock ridge and ice slopes suitable for crampons, leading to a heavily corniced summit. We found ourselves on a part of the western wall of the Lomme Bay Glacier. This glacier starts near Mount Newton and flows northwards to enter Lomme Bay in Hinlopen Strait. On the glacier's eastern side is a mountain wall ; on the map illustrating the Oxford expedition it is marked as the Chydenius Mountains. Through passes in that range we could see what we thought was Hinlopen Strait and North-East Land. Our view down the glacier ended in the New Friesland Ice Sheet. During the 1923 Oxford Expedition the sledging party passed along the eastern side of the Chydenius Mountains; Odell and Irvine, in a side journey, crossed the range, skied across the Lomme Bay Glacier, and reached the Stubendorff Mountains, where they climbed a peak since called Mount Irvine.* The peak we were on must lie about 3 or 4 miles south of Mount Irvine, but it has not proved possible as yet to connect my survey with the Oxford survey. As I am preparing a further expedition in which I hope to clear up the very confusing topography of the Stubendorff Mountains, it seems hardly worth while stating either the difficulties or the conjectured solutions.

Next day the weather broke. In a strong wind frozen snow particles were driving down out of dark stormy clouds. To us it seemed obvious that we could do no further work in that region, and, packing up our gear, we moved down to the dry glacier. Apparently it was only a local mountain storm, as the coast was bathed in sunshine. From some distance away we could see the smoke of Pirie's fire, and in due course we rejoined him at Camp 3. By this date, August 23, the sun was low at midnight, and we had some hours of sunset sky. We sat by the shore by Pirie's fire of driftwood and rejoiced in being able to brew tea without any thought about economy of fuel. Those midnight hours were wonderfully peaceful. The red of the sunset turned the seaward end of the Mittag-Leffler Glacier to the delicate pink one associates with Alpine peaks at sunrise. Seals came quite close to us, and ducks swam past along the shore within a few yards.

Our return route to Ebba Valley lay for the most part up the Mittag-Leffler Glacier. Our plans included visiting the various nunataks. To avoid a crevassed area we kept up the eastern side of the glacier to close under the point S 5, then marched straight across to the most northerly of the nunataks, and climbed it on the south side. This particular nunatak is a fine outstanding lump of rock, its precipitous north face standing 600 feet up from the ice. Rather less than 2 miles to the south is a second nunatak, also precipitous on the north, but easy of access on the south. We camped on the second nunatak on pleasantly flat ground by the side of a small lake lying between the ice and the rock. From the top of this nunatak there was an exceedingly good general view of the glacier. On the western side of the glacier the rock is of carboniferous age and relatively soft, whereas the eastern side consists of Hecla Hook rocks relatively hard and metamorphosed. The nunataks are also Hecla Hook, and form in the southern continuation of their line a ridge or barrier of hard rock which holds up and confines the glacier. The result is that the main flow of the glacier is along its eastern side, and that to the west of the line of nunataks there

Alpine Journal, Nov. 1923.

Unnamed valley from summit of S 5: De Geer range on horizon right

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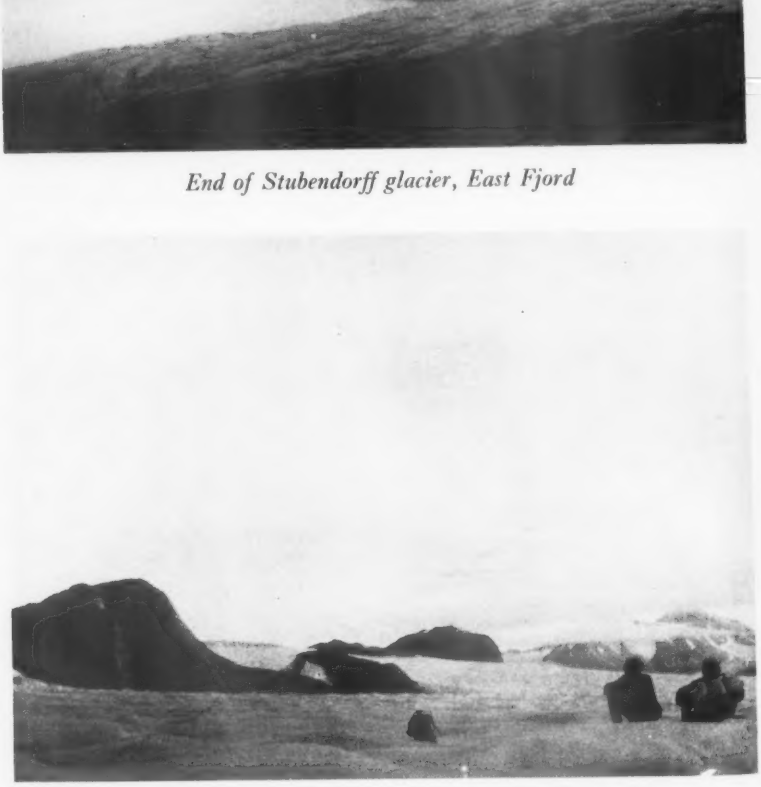
End of Stubendorff glacier, East Fjord



On Mittag–Leffler glacier: N3, N2, and Sphinx

is practically no apparent flow. Hence the glacier appears to move not only towards East Fjord but also towards the lower western wall; the medial moraines lié in different directions, those on the east carrying down to the fjord, and those on the west curving round and running westward. On the westward edge two lakes lie in hollows between the ice and the rock, but unfortunately we were near the end of our food supply and could not spare the time to go to the far western side to make a closer inspection.

From the nunatak we had seen the north-east shoulder of Hult, and noted its bearing. Next morning, August 24, we woke to find ourselves in thick mist, but we felt sure that the route would offer no difficulty. We marched strung out in a line as far apart as visibility permitted, and the last man directed the course by compass. We passed a small outcrop of rock, and knew that we were keeping a steady course, and eventually the shoulder of Mount Hult loomed up in front. When we were quite sure that it really was mountain and not one of the illusions which ice and mist can so easily produce, we turned sharp right down the Ragnar Glacier. This glacier proved to be extremely easy; apart from one surface stream, there was nothing to hinder a motor car being driven about on it. During the return journey from Wijde Bay we had dry glacier all the way, and walked unroped in perfect safety. The maximum height on this route between Klaas Billen Bay and Wijde Bay is not more than 1700 feet. Late in the evening we waded the river in Ebba Valley and were back at Ebba Valley hut, and rejoined Monkhouse after ten days' absence. A most cheering sight was a larder well stocked with birds which he had recently shot.

The last stage of the expedition was the boat journey down the fjord to Advent Bay. An 18-foot boat fitted with a lug-sail had been bought for this purpose in Tromsö. With all our gear and four men aboard quarters were rather cramped, but on the whole we had an excellent passage. We left Petunia Bay on the evening of August 26: a fair wind carried us down Klaas Billen Bay; it then fell calm and a brew of pemmican was possible before the wind rose again with much greater force. We sailed the 12 miles across the open part of the fjord in two hours, getting rather more spray over us than we cared for. There was not much ice about, but a sharp look-out had to be kept, as it was not easy to see the small pieces in a choppy sea with white breaking crests. The whole passage from Petunia Bay to Advent Bay took twelve hours.

At Advent Bay we found a collier just on the point of sailing. Previously I had been in communication with the Store Norske Coal Company, and they had very kindly arranged that we could have passages on their transports. Matters were soon fixed up and berths found aboard *Dagny II*, and four days later we arrived at Harstad.

THE COLOUR OF THE GREENLAND SEA AND THE MIGRATIONS OF THE GREENLAND WHALE AND NARWHAL

DR. R. W. GRAY

FIFTY years ago Peterhead, my native place, still possessed a few sealing and whaling ships which year after year set sail in the spring for the Greenland Sea.* Amongst the Peterhead ships the largest and best known were the *Eclipse* and the *Hope*,† my father's and uncle's‡ ships. Both were three-masted, strongly built wooden ships of about 440 gross tons, and both were fitted with auxiliary engines of about 75 nominal horse power. In the eighteen-eighties I sailed with my father in the *Eclipse* for a number of years in the capacity of mate, and became familiar with the pursuit of seals and whales and with the navigation of the ice.

I have in my possession a number of log-books pertaining to some of the voyages of the *Eclipse* and *Hope*, and although my father and uncle were concerned more with the capture of seals and whales than with a study of their habits, they contain information which if rightly understood seems capable of being turned to scientific account. For instance, they contain frequent reference to the colour of the Greenland Sea, and to the presence or absence in its waters of the small creatures on which the Greenland whale feeds, and also references to the directions in which the Greenland whales and narwhals migrate. The Greenland whale, or *Mysticetus*,§ and the narwhal, like the whales of warmer seas, owing to the manner in which their food is distributed in the waters of the ocean, are often obliged to undertake long journeys or migrations. The behaviour of Greenland whales and narwhals when migrating is characteristic; they pursue a straight course, they project their breath higher into the air than usual, and each time they appear at the surface they may be a mile or two farther on their journey.

It is generally agreed that there is a connection between the colour of the sea and the migrations of whales. Greenland whales and narwhals, as was well known to the whalers, and as I myself have often observed, desert those parts of the Greenland Sea which are clear and blue, and congregate in those which are more or less turbid and discoloured, and in which the creatures on which they feed occur in greater or less abundance.‖ Scoresby ('Arctic

*The "Greenland" or Spitsbergen Sea, *i.e.* the waters west of Spitsbergen.

†The *Eclipse* was built at Aberdeen in 1867; eventually acquired by the Russian Government; and employed under the command of Sverdrup to search for the missing exploring vessels *St. Anna* and *St. Phoca*. The *Hope* was built at Aberdeen in 1873; employed by Peary on some of his voyages; lost at the Newfoundland Seal Fishing in 1906.

‡The late Captains David and John Gray both commanded whaling vessels sailing out of Peterhead, the former from 1849 to 1893, the latter from 1852 to 1891.

§The "Greenland" or Spitsbergen whale, *Balaena mysticetus*. The narwhal or Unicorn *Monodon monoceros*.

‖The whalers ascertained the colour of the water by looking down the "trunk" or "well" in which the rudder of their ship worked, and they sometimes ascertained the presence or absence of "food" or plankton in it by means of a small bag net towed over the stern.

Regions,' vol. 1, p. 175) says: "The colour of the Greenland Sea varies from ultramarine blue to olive green, and from the most pure transparency to striking opacity. These appearances are not transitory, but permanent; not depending on the state of the weather, but on the quality of the water. Hudson, when he visited this quarter in the year 1607, noticed the changes in the colour of the sea, and made the observation, that the sea was blue where there was ice, and green where it was most open. This circumstance, however, was merely accidental. Captain Phipps does not appear to have met with any of the green water. This kind of water occurs in considerable quantity, forming perhaps one-fourth part of the surface of the Greenland Sea, between the parallels of 74° and 80°. It is liable to alterations in its position, from the action of the current; but still it is always renewed, near certain situations, from year to year. Often it constitutes long bands or streams, lying north and south or north-east and south-west; but of very variable dimensions; sometimes I have seen it extend two or three degrees of latitude in length, and from a few miles, to ten or fifteen leagues in breadth. It occurs very commonly about the meridian of London, in high latitudes." The same authority (*l.c.*, p. 176) also says "the food of the [Greenland] whale occurs chiefly in the green coloured water; it therefore affords whales in greater numbers than any other quality of the sea, and is constantly sought after by the fishers. Besides, whales are more easily taken in it, than in blue water, on account of its great obscurity preventing the whales from seeing the approach of their enemies."*

In the case of the Greenland whale, the intimate connection between its occurrence and the colour of the sea is easily understood: diatoms, as is now well known, are mainly responsible for the green colour, and the whale feeds mainly on a small crustacean—the Copepod, *Calanus finmarchicus*—which is herbivorous and feeds directly on these very minute algae. In the case of the narwhal the connection is not quite so obvious, but the cuttle-fish on which it mainly feeds are doubtless also ultimately dependent on the minute diatoms.

Certain questions arise in connection with the discoloured areas of the Greenland Sea, and with the migrations of the Greenland whale and narwhal. Are the areas of discoloured water termed "banks" and "grounds" by the whalers confined to a high latitude, as Scoresby appears to have thought (*cf.* 'Arctic Regions,' vol. 1, p. 547), or do they, owing to the action of the current, drift like the ice south-west, as seems more likely? For the following reasons the latter alternative seems to be correct:

1. The whaling vessels, as may be seen by looking at the extracts from their log-books, commenced the fishing in April or May in lat. 80° (near Hakluyt's Headland) or as far north as they could get, and gave it up in August in lat. 70°

*Greenland whales are not found exclusively in green, more or less turbid water (*cf.* D. Gray, Scottish Fishery Board's 7th Annual Report, part 3, *circa* 1894, p. 366; also R. Gray, "Voyage of *Eclipse* to the Greenland Sea in 1885," *Zoologist*, 1886, p. 52). According to my father, "They are almost invariably found in clean, clear, dark-blue or light olive-green water." Perhaps the whales seen in dark-blue water were adult animals capable of obtaining their food at considerable depths, and hence perhaps the term "blue-water whale," at one time used to signify the very large animals sometimes killed outside or in the outskirts of the ice (*cf.* T. Southwell, "Migrations of the Right Whale, *Balaena mysticetus*," *Natural Science*, 1898, p. 401, and "Notes on the Seal and Whale-fishing of 1887," *Zoologist*, 1888, p. 126).

or 71° off the Greenland coast. Moreover in the interval, speaking generally, they prosecuted it in a lower and lower latitude and in a more and more westerly longitude as the season advanced.*

2. An examination of the log-books of the *Eclipse* and *Hope* (see extracts) shows that the water in lat. 80° loses its green colour in May or June, and that usually after about the middle of June, earlier or later according to the strength of the current, the ships had to look for the green water and for the whales, narwhals, etc., which frequent it south of lat. 75° or 76° off the Greenland coast, and that they found it in a lower latitude and more and more westerly longitude as the season advanced.

The strength of the current, and the rate at which the areas of green water or "banks" drift south-west, appear to be subject to a good deal of irregularity. For instance, in 1880 and again in 1881, according to my father (*Proceedings of R.G.S.*, New Series, vol. 3, p. 740), there was very little south-west drift on the ice and, as the ships' log-books show (see extracts), the water retained its green colour, and the whales were seen and caught in lat. 78° as late as July. The same appears to have been the case in 1876 and in 1878. On the other hand, in 1874 and again in 1887, according to the log-books (see extracts), there was a strong south-west drift, the water in lat. 80° lost its green colour in May, and the ships had to look for it and for the whales south of lat. 75° and west of long. 10° W. after the middle of June.

As the ice drifts south-west along the Greenland coast it melts, and sooner or later the floes are reached by the swell and converted into "pack"; at the same time the "food banks" may get exhausted or sink to too great a depth for the convenience of the whales. In these circumstances it is not surprising that after a time the whales and narwhals cease to accompany the "food banks" south-west. For instance, in the *Eclipse* in 1888 on June 18 in lat. 75°, long. 11° W., we saw to our regret two whales going north-east, and on the 29th, in about the same latitude and longitude, other two going in the same direction.† When the whales and narwhals cease to accompany the drifting "banks" south-west, and turn in their tracks and migrate north-east, they do so, it may be supposed, in the confident expectation of eventually meeting farther north other bodies or areas of green water or "banks" drifting south-west.

How far south-west do the whales and narwhals follow the drifting "food banks"? As already stated, much appears to depend on the state of the ice.

*Owing to the closeness of the ice, whales were seldom killed between lat. 75° and lat. 77°. From lat. 77° to lat. 80½° was sometimes called the "Northern Ground," and from lat. 70° or 71° to 75½° the "Southern." As was well known to the whalers, the ice in different latitudes afforded different sized whales (cf. Scoresby, 'Arctic Regions,' vol. 2, p. 211, and T. Southwell, *l.c.*, p. 401). This seems to be due to the whales of different ages and sex following the drifting "banks" different distances south-west. According to the log-books of Scoresby senior, whales accompanied by calves were rarely seen except early in the season north of lat 79°, and the half-grown animals of either sex were seldom seen after the end of May or middle of June and seldom south of lat. 78°.

†According to her log-book, which I possess, in 1898 the *Active* saw narwhals going north-east on July 20, in lat. 72°, long. 17° W., and the following year the same ship saw whales and narwhals going north-east on June 16 and 18 in lat. 74°, long. 15° W. Again, according to her log-book, in 1873 the *Mazinthien* saw narwhals on July 27 in lat. 74°, long. 12° W. going, *i.e.* migrating, north-east.

When there was plenty of ice off the Greenland coast, whales have been caught as late as August and as far south-west as lat. 71°, long. 18° W., for instance, according to a chart in my possession in 1850 the barque *North of Scotland*, commanded by my father, killed a whale on August 19 in lat. 71° 20′, about 70 miles off the Liverpool coast, and in 1895 the *Active*, commanded by the late Captain T. Robertson, according to her log-book killed one on July 26 in lat. 72° 19′, long. 17° 50′ W. In the same circumstances narwhals were seen equally late and equally far south-west; for instance, in 1895 the *Active*, according to her log-book, saw some on August 6 in lat. 72°, long. 19° W. On the other hand, in very open seasons, *e.g.* in 1879 (see extracts) Greenland whales and narwhals were conspicuously absent off the Greenland coast, and large numbers of fin-whales (? *Balaenoptera musculus* vel *sibbaldii*) appeared in their stead.*

To sum up, it would appear, firstly, that the areas or bodies of green water or "banks" referred to originate in a high latitude and easterly longitude in spring near Spitsbergen, where the sea is usually free from heavy polar ice and where the water after remaining fallow during the winter months first becomes exposed to the light; secondly, that the growth of diatoms and animalcules or plankton that originates in this way, owing to the direction of the current, drifts, like the ice, south-west; thirdly, that whales and narwhals that have migrated north-east early in the season in the expectation of meeting the "banks" accompany them as they drift south-west†; lastly, that sooner or later, according to circumstances, the whales and narwhals that accompany the "banks" south-west turn in their tracks and again migrate north-east.

The second part of my paper concerns the summer wanderings of the Greenland whales and narwhals. According to my father, the whales that followed the "banks" south-west, and were occasionally caught off the Greenland coast, south of lat. 75°, in summer were mostly males. According to him something like a separation of the sexes takes place in the summer months. He says, "The old females with the younger whales of both sexes bury themselves in the polar ice north of lat. 80° after the end of June, where no ship can

*According to my father (*l.c.*, p. 366), "for years (together) there may be no whales found on the feeding banks off the east coast of Greenland. There are various reasons that can be given for this: the ice may not be suitable or so much to their liking as the ice farther north. It also sometimes happens that there are very rich feeding-banks south of lat. 75°, and that in other seasons little or no whales' food can be found. The ice also may occasionally lie too near the land and inside the best feeding-banks. In this case the whales disappear farther north for better cover." "Whales," my father adds, "will never lie on banks where there is not sufficient shelter for them. In fact nowadays, more particularly since the introduction of steam, whales are like rabbits or rats, never to be found far away from their holes."

†Floe-seals or Floe-rats, and their enemies the polar bears, also accompany the drifting "banks" south-west, not to mention an occasional walrus or bearded seal, and numbers of diving and other birds. According to my father (*l.c.*, p. 365), "Greenland whales have no stated period (*i.e.* fixed times) at which they bring forth their young, as I have seen them with very young calves early in May and late in July." "There is," he adds, "a great deal still to be found out as to where the old cows disappear to after calving; for after forty years' whaling experience in the Greenland Sea I have not seen more than a dozen accompanied by calves." See also pp. 74 *et seqq.* of Moritz Lindeman's "Die Arktische Fischerei der Deutschen Seestädte 1620–1868." Ergänzungsheft Nr. 26 zu *Petermanns Geographischen Mitteilungen*, 1869.

follow them, retreating in the autumn southwards as the ice makes in the north. This the whale fishers know from seeing the same class of whale in the following spring, coming up from the south to disappear again in the Arctic ice when it opens sufficiently to allow them breathing spaces and room to feed in." Similarly, only a section of the narwhals accompanied the drifting "banks" south-west; the others, like some of the whales, disappeared in May or June—sooner or later according to the season—into the impenetrable ice and, like some of the whales, were not seen by the nineteenth-century whalers until the following spring, when they too were once more seen amongst the ice coming up from the south-west and from the direction of their supposed winter quarters, between Iceland and Cape Farewell.

Why some of the narwhals should follow the drifting food "banks" south-west and pass the summer south of lat. 75° off the Greenland coast, and why others should disappear in a northerly direction amongst the impenetrable ice, are questions I am quite unable to answer. In their case a separation of the sexes does not appear to take place, for narwhals accompanied by calves were often seen in summer off the Greenland coast (cf. R. Gray, "Voyages of the *Eclipse* in 1885 and 1888," *Zoologist*, 1886, p. 53, and 1889, p. 96); and according to Nansen's 'Farthest North' (vol. 2, p. 546), in 1895 the observers on the *Fram* saw male narwhals in June amongst the ice very far north.

It thus appears that in summer important sections of the Greenland whales and narwhals deserted the Greenland Sea and passed beyond the ken of the whalers, and the interesting question arises: to which part of the Arctic Ocean did they go? Let me begin by making a few general remarks:

1. The migrations of the Greenland whale and narwhal seem to be very similar, as shown by the charts and extracts from log-books sent herewith. Both species were often seen on the same occasions, and when the whalers were on the out-look for Greenland whales they regarded the appearance of the narwhal as a good omen, and in the spring, in lat. 80°, the narwhal often proved the harbinger of the whale (cf. Scoresby, 'Journal of a Voyage to the Greenland Sea in 1822,' p. 40, and log-book of *Hope*, May 1888).

2. When in the northern part of the Greenland Sea whales and narwhals were seen year after year migrating northwards, it may be supposed that their destination was some "food bank" which, owing to the direction of the current, was, like the ice, drifting towards the Greenland Sea, and that having reached it they accompanied it as long as the ice permitted, or as long as the food lasted. These areas of green water or feeding banks appear to originate in those situations in which, owing to the direction of the prevailing winds and the proximity of land, the sea is usually free from heavy polar ice, and where the water, after lying fallow all winter, in the spring becomes exposed to the vivifying effects of light.

3. Lastly, certain facts connected with the whale fishery must be borne in mind. It commenced in the seventeenth century and was continued almost without intermission down to a decade or two ago, but after about 1820 only on a small scale. Hundreds of ships manned by thousands of men were at one time engaged in it. From first to last a vast number of these great animals were destroyed, and possibly entire tribes of them, each with its own summer and winter resorts and migratory routes, exterminated or rendered very scarce.

In the case of the narwhal the facts are different: it was seldom caught by the whalers, and doubtless still exists in undiminished numbers in the Greenland and Arctic Seas. Hence in situations in which, according to the log-books, narwhals only were seen (*e.g.* in lat. 80°, migrating north-east) it does not follow that in former times, when Greenland whales still existed in undiminished numbers, they were not also seen in the same situation migrating in the same direction.

Where then did the Greenland whales and narwhals that deserted the Greenland Sea go in the summer months? Did some of the Greenland whales, possibly a distinct tribe, as Scoresby ('Arctic Regions,' vol. 2, p. 211) seems to imply, migrate north-east in the direction of the waters north of Siberia, where much open water, even in winter, is said to occur (cf. 'Polar Problems,' pp. 118 and 137), and whence owing to the direction of the current the growth of diatoms and plankton, that presumably in the spring takes place, must drift towards the Greenland Sea? For the following reasons the answer appears to be in the affirmative:

1. Scoresby (*l.c.*, vol. 2, p. 211) speaks of a tribe of Greenland whales, mostly adults and probably breeding females, seen in lat. 80° near Hakluyt's Headland in spring, that disappeared, doubtless into the ice, in a north-easterly direction, about the end of April.

2. According to the log-books of the *Eclipse* and *Hope*, numbers of narwhals were frequently seen in lat. 80° in May migrating north-east. For instance, in 1887, in lat. 80°, long. 5° E., on May 27, numbers of narwhals passed the *Eclipse*, all going north-east, and in 1888, near the same place, on May 19, narwhals were again seen going north-east.

3. The members of the *Fram* expedition saw numbers of narwhals in May and June north of Franz Josef Land, which doubtless came from the Greenland Sea and which may have been on their way to meet a drifting food bank coming from the direction of Siberia. For instance, in 1895 Dr. Nansen saw a school of them on May 19 in about lat. 83°, long. about 65° E., which appear to have been migrating east, and the same year the observers on the *Fram* saw others on June 22 in about lat. 84½°, long. 80° E.

4. According to Nordenskiöld ('Voyage of *Vega*,' vol. 1, p. 418), Wrangel ('Narrative of an expedition to the Polar Sea in 1820–1823,' introduction, pp. lvi and cxxvi), and Billings ('Account of an expedition to the Eastern Ocean in 1785–1794'), whales, doubtless Greenland whales and narwhals, were reported by Russian travellers in Siberian waters, and their remains (ribs of whales and tusks of narwhals) have been found on the shore of the New Siberian Islands.

5. A connection appears to have existed between the strength of the south-west current and the number of Greenland whales seen and caught in the spring in the northern part of the Greenland Sea. In seasons like 1874 and 1887 (see extracts from the log-books of the *Eclipse* and *Hope*) in which there was a strong south-west drift and more ice than usual drifted south-west through the Greenland Sea, and in which much open water was presumably left in its place north of Siberia, the whales quickly disappeared into the ice and fewer than usual were seen and caught. On the other hand, in seasons in which the reverse was the case, *e.g.* in 1876 and 1881 (see extracts), the migrations of the

whales were interfered with and more of them than usual, especially small ones, were seen and caught and much harm done to the species.*

6. According to a Dutch authority quoted by Scoresby ('Arctic Regions,' vol. 2, p. 215), the Greenland whales, and doubtless also the narwhals, reappeared in the northern part of the Greenland Sea in the autumn near Hakluyt's Headland; and the fishing, at that time at a standstill during the summer, recommenced in the autumn (see also Phipp's "Voyage to the Greenland Sea in 1773" in Pinkerton's 'Collection of Voyages,' London, 1808–1814, vol. 1, p. 560).

Did other Greenland whales and narwhals, again possibly belonging to distinct tribes, migrate in a north-westerly direction towards some feeding-ground near the Greenland coast, where in spring much open water is said to occur (cf. 'Polar Problems,' *l.c.*), and where a great growth of diatoms and animalcules doubtless takes place? For the following reasons the answer again appears to be in the affirmative:

1. According to the log-books, Greenland whales and narwhals were seen in the northern part of the Greenland Sea migrating north-westwards. For instance, in 1877, on May 25, long. 2° W., long. 1° 30′ W., many narwhals were seen in lat. 79° migrating north-north-west, and in 1876, on July 7, a Greenland whale was observed in lat. 78° 40′ migrating rapidly in the same direction (as regards the Greenland whales see also Scoresby, 'Arctic Regions,' vol. 2, p. 214, and Southwell, "The Migrations of the Right Whale, *Balaena mysticetus*," *Natural Science*, vol. xii, p. 400).

2. According to the *Danmark* Expedition Reports (1906–08) ("Meddelelser om Grønland," vol. 44), the remains of Eskimo dwellings and the bones of Greenland whales and narwhals, presumably killed by them in summer or autumn, occur frequently in a high latitude on the shores of the Greenland coast.

3. The heads of Eskimo harpoons or lances, made of stone, have been found in Greenland whales killed in the northern part of the Greenland Sea. Scoresby (*l.c.*, vol. 1, p. 10) mentions more than one instance, and another occurred in 1866. The whale in this case was a small one, killed by the whaler *Kate* of Peterhead in lat. 80° in May or June (D. Gray, *l.c.*, p. 366).

Finally, did other Greenland whales and narwhals, also possibly distinct tribes, migrate northward towards the Pole, where the sea in summer, except where covered by thick polar ice, must receive an unusual amount of light, and where a considerable growth of diatoms and plankton conceivably occurs? For the following reasons the answer seems to be again in the affirmative:

1. According to the log-books of the *Eclipse* and *Hope*, Greenland whales and narwhals were sometimes seen in the northern part of the Greenland Sea in spring migrating north. For instance, in 1874, on May 5, in lat 78° 13′, long. 1° 34′ W., great numbers of narwhals were observed by the *Eclipse* migrating north, and in 1877 Greenland whales were seen on May 28 in lat. 78° 13′, long. 2° 44′ W., about the same position migrating in the same direction.

2. In 1896 the observers on the *Fram* saw narwhals on May 17 in lat. 83°, long. 12° E., a position which is in a northerly direction from the Greenland Sea.

*In 1874 only one whale was caught in the Greenland Sea, and in 1887 only three; on the other hand in 1881 twenty-three were caught by the *Eclipse* and the *Hope*, in 1876 thirteen, and in 1878 twenty.

THE BRITISH ARCTIC AIR ROUTE EXPEDITION

THE work of the B.A.A.R.E. in Greenland is approaching its end, and it may be convenient to give a brief summary of its many activities since our last account in the June number of the *Journal* which ended with the news that Mr. Augustine Courtauld had been seen from the air returning with the search party. Apart from the information brought by Captain Ahrenberg's relief aeroplane there has been nothing but the necessarily brief radio messages to *The Times*, which have described a very successful reconnaissance and an almost complete ascent of Mount Forel to a height of about 10,900 feet. The climbing party also climbed four other peaks of about 10,000 feet, so that they must have rich material for approximately mapping this hitherto unknown region, which seems to be the highest in Greenland.

On returning from Mount Forel Watkins made a series of plans for a remarkably energetic wind-up of the expedition, including two sledge journeys right across the different parts of the west coast and a voyage right round Cape Farewell to Julianehaab. The first crossing from Angmagsalik to Ivigtut by Scott, Stephenson, and Lindsay is already accomplished, and the party have reached England. Rymill and Chapman are making a traverse farther north *via* the ice-cap station to Holstensborg, while the coast voyage is to be undertaken by Watkins, Lemon, and Courtauld, who will apparently be the last to return. These three journeys account for eight of the fourteen members of the expedition, so that only six are left to return in the *Gertrud Rask*, which is making the annual voyage to Angmagsalik and reached that port some time before August 10, having apparently been less delayed by the bad conditions this year than was Dr. Lauge Koch's ship on its way to Scoresby Sound.

We had hoped to hear Mr. Watkins's account of the expedition's work at the first meeting of the session on November 2, but it now seems impossible that he can be home in time to lecture on that date. But the Society will wish to take the earliest opportunity of congratulating the whole party upon a remarkably successful expedition, in which a very large part, if not the whole, of their performance was carried through without serious accident and with only one temporary anxiety. There was a passage in Mr. Watkins's last report which puts the reason of their success in a clear light. Speaking of the equipment for the coastal journey in motor boats with *kayaks* in reserve he says: "The kayaks which we are using are of the ordinary Eskimo pattern, made slightly larger to fit ourselves. The Eskimos on this coast are generally acknowledged to be the best kayaking natives in the Arctic, so that we have had the best instruction possible. Most European travellers in the Arctic have considered that it would be impossible for a white man to use a kayak or, even if he could use it, to become really efficient in it. We saw no reason for supposing this to be the case; indeed, we considered that it would be possible for some white men to become far more expert in the use of the kayak than any Eskimo. Ten of us had kayaks made, and for the last month or so have been hard at practice. Already most of us can roll right round under the water and come up the other side, a feat which only about one in four Eskimos on this coast can do. One or two of us can roll right round without using the paddle, which only a few Eskimos here can do."

REVIEWS

EUROPE

ENGLAND OF THE WINDMILLS. By S. P. B. Mais. *London: J. M. Dent & Sons* 1931. 8×5 *inches;* xxx+268 *pages; illustrations and map.* 7*s* 6*d*

Ostensibly dealing with windmills, this book is *de omnibus rebus et quibusdam aliis*. The day of our English windmills being almost done—"in all England there are now less than two hundred still working,"—there has recently been an outcrop of wistful literature concerning them, satisfying a natural curiosity about a passing industry and dwelling on the charm in the landscape of long sweeps on black or white cones. It is not so much for any originality in the matter—indeed, as to windmills and many other items this is plain réchauffé—as for the author's enthusiasm for remote country and his easy way of imparting somewhat superficial information that we commend this book, the writing of which was prompted largely by the illustrator and by the writer's own sincere wish to attract readers to green and pleasant places. On a tour it is well to have a hobby: one makes an Odyssey to collect Roman villas, another iron sites, a third Saxon churches, a fourth mediaeval houses, a fifth French châteaux, and so on. Why not windmills? In the counties here traversed—Sussex, Kent, Bucks, Essex, Suffolk, Norfolk, Cambridge, and Lincolnshire—one may be sure Mr. Mais keeps his eyes open for many things other than windmills, which are in truth the lure to get the tourist to start and proceed, keeping as far as possible from main roads and crowds. Mr. Mais well says, "if you have no objective, the inclination to explore vanishes," and makes the good suggestion that dying windmills should be given "a fresh lease of life as hostels for young men and women on trek." On p. 12 there is a fine ambiguity about the translation of a Greek inscription on a Saxon glass vessel, and on p. 125 Verulanium is a mis-spelling. S. E. W.

THE ANCIENT BRIDGES OF THE NORTH OF ENGLAND. By E. Jervoise, A.M.INST.C.E. *London: The Architectural Press* 1931. 7×5 *inches;* xii+146 *pages; illustrations.* 5*s* 6*d*

This is a companion to the volume on the South of England, reviewed in *G.J.*, vol. 77, page 166, and deals with the six northern counties only, leaving the whole of the Midlands still to be done. It is a useful and painstaking record; but it is difficult to avoid the feeling that this attractive subject might have been more attractively set forth. The photographs, illustrating no fewer than eighty bridges, are for the most part unworthy. For example, the beautiful Newby Bridge near the foot of Windermere appears as a very wooden affair; and the bridge at Coverham Abbey is made to look commonplace, though we are told that the style is so unusual. It was a mistake to put two pictures on a small page; the few whole-page views give a better idea of the structure, proportions, and setting. But even the frontispiece of the splendid arch of Twizel Bridge (famous in history as the key of Flodden Field), though rightly displaying the remarkable ribbing, does not give the full stature; and the graceful pair of arches at Lanercost appear without their abutments. A few scale-drawings would have had value and might have been expected from an engineer. J. H. R.

THE LAKES OF WALES. By Frank Ward. *London: Herbert Jenkins* 1931. 9×6 *inches;* 264 *pages; illustrations and maps.* 10*s* 6*d*

Cambria is often compared to Cumbria; and one of the principal points of difference is the almost complete absence in Wales of sheets of water at all comparable

with the English Lakes. The Barmouth estuary at high tide is the nearest thing; Llyn Tegid, commonly called Bala Lake, may be ranked with Bassenthwaite Water. Even when Welsh lakes, like Ogwen, Gwynant, and Cwellyn, lie on the floors of the main valleys they seldom exceed a mile in length, though Llyn Padarn extends for 2 miles. It is noteworthy that there is no special Welsh word to distinguish a tarn from a lake. The great majority of *llyniau*—and no fewer than 541 (including ponds and reservoirs) are catalogued in this book—are tarns; from Snowdon the landscape appears peppered with them, and we read that there are over a hundred in Merionethshire alone. As tarns, the lakes of Wales can hold their own in any company at furnishing a pleasing prospect, though man in some cases has been extraordinarily vile. Mr. Ward has something to say about the scenery and physical features, frequently notes the meaning of names, and, wherever possible, relates any legends associated with particular localities; but the book is mainly intended for the angler, who will find a mass of information about the quality and permissibility of the fishing. The author observes that the size of trout in artificial lakes is subject to regular phases, growing rapidly at first from the wealth of food in submerged pastures, then steadily declining with the silting up caused by the dam. He adds an interesting note that to improve the food supply for the fish over 1½ million snails and shrimps have recently been placed in Lake Vyrnwy. Whether *they* will find sufficient food is another question. J. H. R.

HANDBOOK OF CORNISH GEOLOGY. By E. H. Davison. *Truro: Oscar Blackford* 1930 (*2nd Edition*). 9×6 *inches; 112 pages; illustrations and maps.* 6*s*

The fact that a second edition of this little book, first published in 1926, is already called for is a testimony both to the interest of the subject and the excellence of the treatment. In few counties can the physical and the human geography be so directly dependent on the geology as in Cornwall. After a brief general description the author first discusses the Lizard, an area unique in England and increasingly popular as a quiet holiday resort, but having little in common with the geology of the rest of the county. The relation of the granite bosses to the palaeozoic rocks into which they are intruded is described in simple language without any loss of accuracy, and the same may be said of the more intricate subject of the origin of the mineral lodes. It is an advantage to have the pneumatolytic origin of the China Clay unequivocably stated; most popular guides, after alluding to the eyesore caused by this important industry, repeat the now discarded theory of the formation of the clay by atmospheric weathering of granite.

The movements of the land relative to the sea from Pliocene times to the present day are shortly stated. The platforms at about 1000, 750, and 400 feet respectively above sea-level, the raised beaches, and "drowned" river estuaries indicate various stages in elevation and subsidence, and account for the more conspicuous features in the Cornish scenery. Particularly useful is the list of localities and exposures where the geological phenomena described can be easily studied. An interesting point in plant-ecology is noted: lime is scarce in Cornish rocks, but the "towans," or sand-dunes, consisting largely of shell fragments, support a few lime-loving plants not found elsewhere in the county.

More might perhaps be said about Wolframite, the ore of tungsten; as a valuable by-product it prolonged the life of several of the tin mines for a number of years; the Geological Survey Memoir on Tungsten should be added to the bibliography. This is a useful addition to the book, but H. G. Davis is a mistake for H. G. Dines. The legend of the map of the Lizard is rather difficult to decipher. We note these minor points in confident expectation that a third edition will soon be needed. C. N. B.

THE OTHER CHATEAU COUNTRY: the Feudal Land of the Dordogne. By KATHERINE WOODS. *London: John Lane* 1931. 9×6 *inches;* xiv+280 *pages; illustrations and map.* 18*s*

The distinction implied in the title words is between the Dordogne and the better-known Loire country. The author, who does not omit practical hints, sets down for travellers and for "those who travel through books" some of the things which interested her in a very beautiful but little-known country, full of historical associations and mediaeval legends connected with such names as Périgord, Bergerac, Périgueux, and Rocamadour. The region described, through the more southern portion of which flows the river Dordogne, extends from Périgueux eastward to Tulle, Bretenoux, and St. Céré. Along with excellent descriptions of castles, towns, and landscapes is given detailed information for motorists about roads, hotels, costs, etc. The best roads from the north to the Dordogne pass through Angoulême: one may agree with the writer that "the mountains of Auvergne and Cantal are strange and rather terrifying." The reviewer certainly found them so with snow on the ground. For an effortless reconstruction of feudalism the historically-minded should go to the rich Dordogne valley, the scenic setting in which lords and ladies, knights and vassals, monks and troubadours played their parts. "The view from Beynac is more than a view: it is a period of history"; and so almost throughout these pages. The author has a style which is correct and pleasing, alert and eloquent, enhancing her well-informed narrative, which the appropriate picture is always at hand to illustrate, so that her very charming book creates a longing for adventures off the beaten track among the Dordogne châteaux and bastides. Périgueux is the best headquarters, and the large-scale Carte Michelin No. 75 the best map. This is an outstanding travel book. S. E. W.

REGIONI E STATI D'EUROPA. By LUIGI DE-MARCHI and FERDINANDO MILONE. *Padova: Antonio Milani* 1931. 10×7 *inches;* viii+192 *pages.* L.20

Professor De-Marchi is the author of a book entitled 'Fondamenti di Geografica Economica' which has run into its third edition. The present volume is based on the second part of that book, revised with the collaboration of Professor Milone, and is intended both for educational purposes and for a wider public. It deals with the products and trade of all the states of Europe with the exception of Italy. The States are grouped into "natural regions," a term used in a somewhat wider sense than is usual here, and the general geography of these regions is briefly discussed in each case in a preliminary survey, followed by a short account of the economic geography of the individual states included in the region. There are no maps or diagrams, no index, and only concise statistics, as distinct from elaborate tables. Within its narrow limits however the book gives an excellent and up-to-date summary of the economics of post-war Europe, set forth in a clear and simple style, the essential facts being emphasized, though naturally no amount of detail is possible.

In its subject matter the book thus follows familiar lines, similar topics having been elaborated in many recent works, both in English and in German. The treatment is of interest, in the first place because comparisons are made throughout with the Italian homeland, so that, for example, the contrasts between Spain and Italy are well brought out. Secondly, the authors' views on the best method of dividing Europe into regions are of interest in that there is still much diversity of opinion on this difficult subject. The arguments used to support the inclusion of Germany, Poland, Holland, and Switzerland in the *Regione Polono-Germania*, while Czecho-Slovakia, Austria, and Hungary fall into the *Regione Boemo-Carpatico-Danubiana* should be noted by those concerned with the problem. The

outstanding feature however is the way in which the authors succeed in giving a broad and attractively written outline of Europe with the minimum of paraphernalia, and without a single segmented circle or linear diagram—devices so heavily overdone in some recent books. M. I. N.

AUSTRIA. By J. D. NEWTH. *London: A. and C. Black* 1931. 9×6 *inches;* x+208 *pages; illustrations and sketch-map.* 7*s* 6*d*

This is the third travel book on post-war Austria which has been published in England, the other two being Baedeker's guide (1929) and Gedye's 'Wayfarer in Austria' (1928). With the first of these the present volume obviously does not compete; but it presents in its methods and line of approach many points of similarity to the second. So close, indeed, is the resemblance at times that the question forces itself upon us whether this latest book fills a genuine need. Mr. Gedye in his charming volume has contrived to combine a scholar's accuracy, an artist's taste, and a raconteur's wit more successfully than any other travel writer we know. What more has Mr. Newth to offer us? His book is of a much lighter texture, more concerned to convey the impressions of the moment than to plunge deeply into the artistic and imaginative life of the people. The intending traveller to Austria can easily digest it at a sitting, and at the end he will have a very fair idea of the varied beauty of the land and the unvarying charm of its inhabitants. He will be greatly helped to visualize the Austrian scene by the wholly delightful series of twenty-four illustrations in colour by Mr. E. Harrison Compton.

The book is, in fact, excellent as a first introduction to Austria. Mr. Newth wisely encourages the traveller to explore more widely into little-known Styria and Carinthia after paying his respects to the famous glories of Salzburg, Tirol, and Vienna. He ranges from place to place like a butterfly on the wing. The view is extensive, but much picturesque and practical detail is lacking, and what is given is not always exact—for example, the rack-and-pinion railway up the Gaisberg just outside Salzburg has been discontinued since the completion of the *Gaisbergstrasse*. The style is light and easy, and the book as a whole undeniably successful in conveying the attractive qualities of its subject. The short section on Vienna and the Viennese was vivid and truthful enough to arouse a keen *Heimweh nach Wien* in the reviewer. D. C. S.-T.

FINLAND. By KAY GILMOUR. *London: Methuen & Co.* 1931. 7×4 *inches;* xx+182 *pages; illustrations and maps.* 6*s*

This book is a guide and something more—an enthusiast's encomium on Finland, her people and her culture. The first chapter gives precise information to intending travellers on routes to Finland and locomotion in the country itself together with outlines of possible tours, hotels, money values, etc. In succeeding chapters the author deals with Finnish problems and their solution, such as the development of a united people in face of racial difficulties and the rapid creation of a democratic republic after 700 years of foreign subjugation. Throughout the book there is unstinted appreciation of the national virtues of honesty, cleanliness, endurance, and enterprise; and of the national genius as manifested in art (especially architecture) and in literature. The educational system, which cares for the intellectual development of the subject from babyhood to twenty-five, receives its due meed of praise. Approval is expressed of the measures taken to deal with house-shortage, but at this point the reader may feel some curiosity as to the salaries of "professional women" who can afford £109 per annum for rent, even though that covers central heating. Some description is given of the principal towns besides the capital—to mention a few only, Turku (Åbo), the

former capital; Viipuri (Viborg); Tampere (Tammerfors), the Manchester of Finland; Kuopio and Hanko. Tastes will differ, and probably many will demur to the statement that Turku is the most beautiful city of the republic. Nor has it been every one's experience in respect of Valamo that "monastic simplicity includes . . . public washing facilities," while for the traveller to arrive with his own stores seems superfluous in view of the good food provided by the monks in their guesthouse restaurant. E. G. W.

TURI'S BOOK OF LAPPLAND. By JOHAN TURI. Edited and translated into Danish by EMILIE DEMANT HATT. Translated from the Danish by E. GEE NASH. *London: Jonathan Cape* 1931. 8×5 *inches; 294 pages; illustrations. 7s 6d*

This is a remarkable book and deserves attention. Written by a native of the region described, who has spent his whole life there, it bears the stamp of truth; and yet so remote from ordinary experience are the conditions portrayed that they seem hardly credible. No educational ladder, one knows, ever invited the steps of the infant Turi, and intercourse both with men and books was denied him; yet he reveals himself here as at once a graphic and convincing writer, a philosopher, a historian and, not least, an artist. For many years, Turi tells us, he had planned the work, "having heard tell that the Swedish Government will help us all they can, but they don't really understand our life and circumstances, and no Lapp can explain it to them," for a Lapp's brains are no good "unless the wind's blowing through his nose." The Lapp's chief trouble is that the settlers, unable to realize that the narrowing of the nomad's boundaries meant taking from him the power to live, have gradually encroached on the lands formerly free for migrations.

The production of the book is due not only to the author but also to the efforts of the intrepid Danish lady, who interpreted so liberally her duties of editor and translator as to be prepared in addition to meet all the varied demands of daily life in the Arctic wilds because, as she self-effacingly remarks, "an author should not be disturbed by household cares." Within the limits of a brief review it is difficult to give any clear idea of the scope of the book, which includes not only a vivid account of the daily life, beliefs, and customs, but also chapters on Lapp doctoring, folk-lore, and magic, on the trapping of wild animals, on the animals themselves, and on Lapp song.

Turi's story of the Fell-Lapp's daily life, bound up as the life is with that of his reindeer herds, is illustrated by a remarkable series of drawings, given at the end of the book. The description reveals how many of those qualities, usually held among the highest found in the human race, such as courage, fortitude, a high degree of efficiency, etc., are needed for successful living, or even for living at all, seeing how narrow is the margin between well-being and disaster. One cannot feel surprise even when Turi expresses the fear lest the children's schooling, if prolonged, should endanger the development of those peculiar aptitudes which distinguish the "Lapp mind" from the "peasant mind." The chapters on Lapp doctoring, on folk-lore, and on wild animals are packed with information and interest. As regards the first, one marvels almost more at the amount of useful, commonsense knowledge displayed than at the masses of empiricism and superstition compounded with it. The animal lore is full of quaint ideas and quiet humour, especially the story of the dog's domestication, the account of the tussles with "Old Man Furry," the story of the loon's resentment as to its feet, and the descriptions of the birds, some friendly and some of ill-omen.

Turi's anxiety with regard to his people's future is evidently great. "One can well believe," he says, "that the Crown sees that the Lapps have been neglected

like a bastard child," and the editor makes it clear that "if things continue in this way the end will be death and destruction for the race to which Turi belongs and whose life he leads." We cannot but rejoice that the cause has found so able an advocate, for surely there is something valuable and worthy of preservation in a race so endowed with powers of endurance and cleverness as to face almost daily supreme hardship, whether the perils of snow or flood, the menace of sickness or the ravages of wild beasts; in which a woman bearing a child during the migrations just tucks it into her tunic and continues to drive the herd until the evening camping-place is reached; a race whose young men and maidens become so light-hearted as the spring approaches that they burst forth into song, and whose old folk, in spite of the great risks they run of wandering astray during the long journeys, are yet content, as Turi is, "to remain in God's care, like a child on its mother's knee, where is its best refuge." E. G. W

E. v. SEYDLITZ'SCHE GEOGRAPHIE: Hundertjahr Ausgabe: Band II, Europa (ohne Deutschland). *Breslau: Ferdinand Hirt* 1931. 9×6 *inches;* xii +1196 *pages; illustrations and maps. M.*48

Any serious attempt, made with competent authority, to deal with the regional geography of Europe must claim the interest and attention of geographers, and this centenary edition of the well-known German handbook may lay special claim to such attention. V. Seydlitz's 'Geographie' appears to have undergone much the same process as certain other standard German text-books. From purely school—though not necessarily elementary—texts, they have evolved into manuals—something more than class texts and rather less than reference books or encyclopaedias. This quality makes them rather puzzling both to the reader and to the reviewer, and the latter's task is not rendered easier by the nature and composition of the present volume. The two thousand or so well-filled pages are the joint product of twelve authors—two of them now deceased—working under three editors. They deal with an area of exceptional variety and interest, the core of which however is relegated to a separate volume (Germany: Vol. I of the complete work). The list of collaborators includes names of high repute amongst continental geographers, and while the presentation is formal and systematic this, in a good modern German text-book, by no means always implies dullness or aridity. Part of the interest indeed which attaches to a work like the present is that it illustrates, to some extent explicitly and consciously, certain ideas and methods in presenting geographical materials in a way suitable for systematic instruction.

An introductory survey of Europe as a whole is followed by a similar section on *Central Europe*. Both of these sections are appropriately by Machatschek. *Central Europe* is divided into (A) Alpine Lands (Switzerland; Liechtenstein; Austria). (B) Sudetic and Carpathian Lands (Czechoslovakia; Hungary; România). (C) Poland. (D) Western borderlands (Netherlands; Belgium; Luxemburg); and, naturally, Germany (*v. sup.*). Each of these divisions is provided with a general introductory survey and the treatment of the individual countries is in the hands of qualified authorities.

The section on *Western Europe* comprises a general survey, and a detailed treatment of Great Britain and Ireland and France. *Southern Europe*, with a general survey of Mediterranean Lands (O. Maull), covers the Iberian Peninsula, Italy, and the Balkan States (including Bulgaria and European Turkey). *Eastern Europe:* the general survey here includes a lengthy section on the "natural regions" (Landschaften), and this is followed by a detailed treatment of Russia and the Baltic States. Finally, *Northern Europe*, besides a general survey, includes Denmark, Iceland, Norway, Sweden, and Finland, as well as a note

(G. Braun) on "The North Scandinavian Region." There follow three sets of statistical tables illustrating facts of the physical, economic, and political geography of the area covered in the text; tables of German equivalents for foreign place-names, and a comprehensive index.

To criticize the subject-matter of the text is beyond the scope of a review such as this, and also beyond the competence of the reviewer. The treatment appears to be thorough and, it may be assumed, embodies what the authors and editors regard as standard matter for instruction upon the areas dealt with. The section devoted to the British Isles, with which must be included the general survey of Western Europe (rather less than 100 pages in all), would hardly satisfy the requirements of teachers in this country, nor, of course, should it be expected to do so. As compared however with the space and treatment accorded to the British Isles in some other foreign text-books, the present volume marks an appreciable advance and, apart from details which may be open to criticism, evidently seeks to give a balanced, scientific, and comprehensive survey within the limits stated.

As regards the selection, handling, and arrangement of the subject-matter, some general features may be noted. The treatment throughout is severely systematic. Whether this implies dullness and heaviness would probably best be judged by actual use. Appearances are rather to the contrary and, in any case, feelings on such matters are apt to differ. The treatment of each individual country falls into two main divisions: (i) General Geographical Features (position, size, etc.; surface forms, soils, drainage; climate; vegetation; population and settlement; social, economic, and political features and development). (ii) Regional Description—a detailed "synthetic" survey area by area. The order or arrangement of the materials as between (i) and (ii) differs somewhat from country to country—*e.g.* the regional section is sometimes inserted after "vegetation," and sometimes after "population and settlement" in the above series. The system of division into "regions" ("Landschaften"; "Regionen") adopted deserves close study—compare, for instance, that adopted for Great Britain (p. 368, Fig. 469) with that adopted in 'Great Britain: Essays in Regional Geography.' Such, and other differences in treatment, are significant and are of interest to those desirous of understanding current views regarding the modern science of regions or areas. Not less instructive, and perhaps more welcome to teachers, will be the sections characterizing broader areas: Northern Europe; Western Europe; Eastern Europe, etc., and also such more special, but still general, area-topics as Alpine Lands; Carpathian Lands, etc.

Finally, not a little of the interest of this volume, as of the centenary Von Seydlitz as a whole, is its value as a register, and in some degree an exemplar, of modern methods and technique of presentation. The four elements of geographical presentation: text, maps and diagrams, picture-illustrations, and statistics are all freely used and, it is not too much to say, interwoven with no little skill into a remarkably unified whole. The great bulk of statistical material, it is true—amounting almost to a statistical gazetteer—is collected at the end of the volume. Each country, or close group of countries, has its set of picture-illustrations grouped at the end—24–48 views; British Isles, 34—and these, carefully chosen, illustrate a wide range of physical and human features and give an excellent "living" impression of the character of the area. There are also included, in the course of the text, several full-page coloured views, opinions as to the value of which will differ. Sketch-maps, physiographic sketches, and diagrams (physical, including climatic; settlement; railway; statistical, etc.) are present in abundance and form an outstanding characteristic. The number and excellence of these illustrations is indeed astonishing (cf. the section upon the Alps and Switzer-

land, which are perhaps exceptionally well treated in this respect). Despite the presence of certain sketch-maps which will be regarded as unfortunate or misguided (*e.g.* p. 40, Fig. 40), and despite also the emphasis on German racial and political claims and theories, the maps and diagrams in this volume form a gallery of the highest value and use in demonstration—being, many of them, not easily accessible elsewhere—while many have also no little intrinsic scientific interest and may be found useful even by the specialist. This volume, in fact, in the opinion of the reviewer, represents not only a *tour de force* in one method, and according to one conception, of geographical presentation: it is also something of an achievement in the technique of text-book production. O. H. T. R.

RUSSIA AT RANDOM. By OWEN TWEEDY. *London: Jarrolds* [1931]. 8×5 *inches; 192 pages; illustrations. 7s 6d*

Leningrad and Moscow are not Russia, and a visit to those two cities in company with several hundred tourists and under the tutelage of official Soviet guides can scarcely be said to have been made at random. The programme was most carefully arranged, and the three days of the trip were spent in one long struggle to keep up with it. The author entered Russia with an open mind; and, when he left, some of the blanks had apparently not been filled up. He shows a kaleidoscopic picture of buildings falling drably into decay and streets in shocking need of repair, priceless treasures in museums displayed to stolid soldiers and the imperial rooms at Tsarskoe Selo carefully preserved as propaganda, man and beast well fed but workshops stuffy and overcrowded, remarkable efficiency in one direction and dangerous inefficiency in another, and always and everywhere queues, especially outside sweetshops. He was handicapped by an ignorance of the language (or he would have recognized Stone Island and "Kameny" Island as the same place), and seemed specially worried by English N being H in Russian. His Leningrad guide is rather irritatingly described throughout as "the Vicar's wife"; but it is a readable little book, though some readers may doubt, when they put it down, if they have had 7*s.* 6*d.* worth. J. H. R.

ROYAUME DE YOUGOSLAVIE: aperçu géographique et ethnographique. *Beograd* 1930. 190 *pages;* 9×6 *inches; illustrations and maps*

LIVRET-GUIDE DU III CONGRÈS DE GÉOGRAPHES ET ETHNOgraphes Slaves dans le Royaume de Yougoslavie 1930. 7×5 *inches; prèmiere partie: Beograd-Sarajevo,* 216 *pages; deuxième partie: Sarajevo-Zagreb,* 214 *pages; illustrations and maps*

The first of these two volumes is a French translation of a handbook prepared for the 3rd Congress of Slavic geographers and ethnographers. It is dedicated to the foreign members of the Congress, and in view of the evident goodwill behind this offering in an international language, it seems somewhat churlish to criticize its style and contents. Its defects are, perhaps, largely due to the nature of its compilation. Taken by themselves, the various chapters, each by a different contributor, are carefully written and instructive, but there seems to be a total lack of coordination as to method of approach.

The pages by B. Ž. Milojević make a pleasing contrast. Here is a real geographer with an eye for significant detail and the ability to synthesize his material. With a minimum of words he can make a complete picture, *e.g.* of Mediterranean agriculture in relation to its geography. His style recalls that of Brunhes in *La Géographie Humaine,* and it is a pity that limitations of space did not allow of a longer contribution. The chapter on Geomorphology deserves mention for its diagrams, as it is the only section in which any attempt at illustration is made. Neither in this chapter however nor in those on Geology or Climate is any

attempt made at correlation with the human geography, nor can the short space at the disposal of Milojević for dealing with "Production and Means of Communication" make good this omission.

The Handbook concludes with an account of the recent cartographic and geodetic work of the Institut Géographique Militaire, including the trigonometric survey of the southern part of the kingdom, and the resurvey of the rest of the area with a view to preparing new topographic maps of the whole country.

In connection with the Congress, a Guide to the tours offered to members was also prepared. Although the nature of its arrangement makes it hardly a book to read straight through, yet a good deal of useful geographical information can be extracted by a persistent reader. It is illustrated by diagrams of town sites and by a number of photographs of typical landscapes. M. R. M.

ASIA

ASIA'S TEEMING MILLIONS: AND ITS PROBLEMS FOR THE WEST. By ETIENNE DENNERY. Translated by JOHN PEILE. *London: Jonathan Cape* 1931. 8×5 *inches; 248 pages; illustrations and maps.* 10*s* 6*d*

This is a short and brilliant study of population problems in Japan, China, and India, the greater part of the space being devoted to China. The author is mainly occupied with economic problems, but there is much of interest to the geographer in his book, especially since he is of necessity mainly concerned with the distribution of and opportunities for different types of agriculture in the Far East. The contrast of the different racial characters of the immigrants and their reaction to geographic environment is very clearly sketched: the Chinese, a very capable colonist, especially in the north, willing to put up with a low standard of living for ultimate profit; the Japanese, rather a colonial administrator than a colonist; and the Indian peasant, only driven to wander afield by destitution, and even then a very unwilling colonist. Any one who knows China will regret that the translator has used the word "Chinaman" very frequently and has omitted to give the place-names according to the Chinese Postal Guide; confusion is made worse by adoption of different spellings in the text and on the maps. Otherwise the translation is very successful. There is a short bibliography, some excellent photographs mainly of Chinese emigrants, but no index. The maps are simple, straightforward, and clear. L. H. D. B.

REISEBESCHREIBUNGEN VON DEUTSCHEN BEAMTEN UND Kriegsleuten im dienst der Niederländischen West- und Ost-Indischen Kompagnien 1602–1797. Edited by S. P. L'HONORÉ NABER. *The Hague: Martinus Nijhoff* 1930. 9×6 *inches; Vol. I*, viii+98+140+88 *pages.* 7.20 *gulden. Vol. II*, viii+146 *pages; portrait.* 3.80 *gulden*

When at the commencement of the seventeenth century the Dutch began to supplant the Portuguese in the Indies, many of the German soldiers and gunners who had previously gone to Lisbon in search of fame and fortune now shipped themselves for the East in the Low-country ports. A good few of them have recorded their experiences for us, but these works have for the most part become exceedingly scarce of late years, so that all who are interested in the history of European conquest and exploration in the East owe the present editor and publishers a debt of gratitude for reproducing these books together in a handy form. The first volume deals with three men who saw service in the fleets and armies of the West India Company against the Portuguese in Brazil and West Africa, covering the years from 1623–1645. One of them, Aldenburgk, gives us, *inter alia*, a good account of the capture of Saõ Salvador in 1624, as well as of its

subsequent recapture by the Iberian Armada under Don Friderico de Toledo in the following year—one of the few occasions on which the proverbial help from Spain came neither later nor never, but in time. His account is supplemented by that of Richohoffer, a native of Strasbourg, who sailed in 1629 with Lonck to the attack on Pernambuco. Both these writers give us a good account of the operations against the Portuguese on land and sea, but from a geographical point of view their works cannot compare in interest with those of de Zart or Barlaeus, though they have some interesting things to say about the land and products of Brazil.

From this point of view the voyage of Michael Hemmersam is more important, since we owe to him one of the earliest descriptions of Elmina under Dutch rule, as he spent most of his service (1639–1645) in and about that fortress, which had been wrested from the Portuguese in 1637. The editor has an interesting note on this subject in his introduction (p. vii). Hemmersam's description of the customs and habits of the local negro tribes—whether wholly original or not—is also of considerable merit.

The second volume of this series describes the voyage of Johann Verken to the East Indies 1607–1612, and is chiefly of interest for his account of the siege of Mozambique—valiantly defended by the chivalrous Dom Estevaõ de Ataide—in 1608, and his service in the Moluccas in 1609–1611. In this connection he has some interesting things to say about David Middleton's "interloping" efforts, and the consequent friction with the Dutch. Incidentally, it is curious to note that on his homeward voyage in December 1611 Verken met the ship *Halve Maen* in Mauritius road, this vessel being none other than the craft in which Henry Hudson had discovered New York Bay in 1609.

The editor has done his work well, and deserves particular commendation for keeping the annotation down to the necessary bare minimum, without however having omitted any essential indications. Each volume is prefaced by a concise bibliography which puts the reader in touch with any other sources he may need to check the narratives, but it might have been noted in Vol. II that a Portuguese version of the siege of Mozambique exists in Antonio Duran's 'Cercos de Moçambique,' published at Madrid in 1633. C. R. B.

THE EPIC OF MOUNT EVEREST. By Sir FRANCIS YOUNGHUSBAND. *London: Edward Arnold & Co.* 1931. 7×5 *inches;* 320 *pages; illustrations.* 2*s* 6*d*

This is the School Edition of Sir Francis Younghusband's well-known account of the three Mount Everest Expeditions, which was first published in 1926; it is also the first cheap edition. It is not necessary here to do more than refer to the admirable qualities of the narrative: it was fully reviewed in the *G.J.*, vol. 69, page 76, by Mr. Douglas Freshfield, who rightly pointed out that it did justice "not only to the dramatic incidents of the Great Adventure, but also to the spirit that prevailed among those who took part in it." At half a crown the book is splendid value, and it is difficult to imagine the schoolboy who would remain deaf to its appeal. D. C. S.-T.

MYSORE CITY. By CONSTANCE PARSONS. *London: Humphrey Milford* 1930. 7×5 *inches;* xvi+200 *pages; illustrations and plan.* 5*s*

This little guide-book to the city of Mysore, though it contains much eulogy of the reigning family, does not pretend to any wider interests. It gives, for example, no indication of the geographical situation of the city in reference to Mysore State, and no information about the state itself as a geographical entity. Within its own limits however it should prove a readable and useful summary.

W. H. A. W.

CROSSROADS OF THE JAVA SEA. By HENDRIK DE LEEUW. *London: Jonathan Cape* 1931. 9×6 *inches;* xiv+350 *pages; illustrations.* 15*s*

When a traveller of considerable experience comes to write a book the danger is that he may have too much material. If writers of travel books would realize that a book about a single island may be of greater value than a volume about an archipelago, geographical knowledge would be enriched. Mr. Hendrik de Leeuw (a Dutch-American) has fallen into the snare of attempting to make his work too comprehensive. His purpose in writing it was not merely to record impressions, but to produce a book with a scientific background, a book "from which one could learn something," and he has taken the more important of the Dutch possessions in the East Indies as his field: Borneo, Java, Celebes, Sumatra, and Bali. It is next to impossible to produce a book of permanent value with a scope so vast, unless the book be concerned with a special subject, as is Sir Hesketh Bell's 'Foreign Colonial Administration in the Far East.' Mr. de Leeuw, for all his good intentions, would have done far better to have restricted himself to a single island, such as Celebes, which has not yet received the full attention it deserves.

As it is, he devotes a section to each island. That which deals with Borneo is of negligible importance both from a scientific and general point of view; it is confined mainly to a journey by boat up the Mahakam River, and the reader's confidence is undermined by several elementary errors. For example Brooke, not Brooks, is the family name of the rulers of Sarawak, which has had three White Rajahs, not one, as the author suggests. The remaining sections are much better, a pleasant enough mingling of personal experience and shrewd observation, with scraps of history and anthropological information thrown in here and there; the account of Celebes, although only forty pages in length, is particularly deserving of notice. The book is provided with a bibliography, which shows some glaring omissions of recent works published in English, but it contains no index, an extraordinary omission in a work of this kind. On the other hand, the photographs have been well chosen and excellently produced, while the line drawings of Mr. Alexander King (who illustrated Mr. Hickman Powell's recently published book on Bali) have both distinction and originality. O. R.

AFRICA

LA CRISE ECONOMIQUE EN AFRIQUE BELGE. By GEORGES VAN DER KERKEN. *Brussels: Emile Bruylant* 1931. 9×6 *inches;* xii+110 *pages; diagram.* 25 *fr.*

The author of this book, who has had administrative experience in the Belgian Congo and is now a Professor at Ghent University, is interested primarily in economic conditions and in their repercussions upon administrative policy. The first part of his book is taken up with a discussion of the problem of the world-wide trade crisis which has shaken the Belgian Congo in common with other regions whose exports are chiefly primary products. Here he is dealing with matter only too familiar to students of economics.

In the second and more important part of the book M. van der Kerken passes on to an analysis of the unfortunate situation in the Congo. He has hard things to say about the financial and general economic policy of those responsible for the government of the territory; he condemns in particular their handling of the problem of transportation, which remains unduly costly, and the general lack of foresight of all concerned. Incidentally this second section of the book gives a valuable insight into the economic life of the area; its economic geography is laid bare with special emphasis upon essential factors such as wages, problems,

native policy, and net prices realized, which do not appear in ordinary studies in this field, with their tendency towards an arm-chair detachment from realities other than those of the purely geographical order. So far however as the main problem of remedies for the crisis is concerned, the book is rather disappointing.

E. W. S.

THE STORY OF SIERRA LEONE. By F. A. J. UTTING. *London: Longmans, Green & Co.* 1931. 8×5 *inches;* viii+178 *pages; maps.* 4*s*

Mr. Utting's little book is intended for use in the schools and colleges of the Colony and Protectorate, where there has long been a need for a simple history of the country. His natural anxiety to interest his readers has led him into repeating some of the more fanciful theories about West African pre-history which it would have been wise to omit from a book of this character. When he comes to the history of Sierra Leone he is on surer ground. He has made full use of his authorities and tells his story with clearness. The book has been carefully written and seems, with the trifling exception already mentioned, to be well suited to the purpose for which it is intended.

E. W. B.

AFRICA SPEAKS. By PAUL L. HOEFLER. *Philadelphia: John C. Winston Company* 1931. 9×6 *inches;* xii+470 *pages; illustrations and sketch-map.* $3.50

'Africa Speaks' is full of thrills and surprises. Perhaps that is not to be wondered at, seeing that the book is mainly an account of the taking of the wild-animal film which was exhibited recently in this country under the same title. But the most surprising thing about it all was the attitude of the filmed lions towards the photographers. Those who have come across lions are ready to admit that almost invariably an average unwounded lion would retreat rather than attack a man. But on the Serengeti Plains in Tanganyika Territory in East Africa they became so tame as to approach the flimsy enclosure which protected the operators to within a few feet with no evil intent: trotted up to be filmed as soon as the lorry that they had become accustomed to came in sight; and carried away and played with tyres and oil cans left in an unguarded car! Indeed, the author seems to consider the filming of giraffe, which had to be followed by motor at break-neck speed, far more risky than photographing those other reputedly more dangerous animals. Two of the most interesting chapters are those dealing with the Nandi lion-spearers and the destructive locust swarms.

The journey across Africa in 1928–29, which the American expedition completed after taking the animal film, was by way of Kenya and Uganda, skirting north of the Victoria Nyanza and crossing Lake Albert, the Belgian Congo—passing through such comparatively well-known places as Api, Bangui, Archambault, Fort Lamy, and the lesser-known Kiya Be, where the women's lips are distended till they assume the proportions of saucers—and Nigeria, touching only at its principal towns. The business of filming and motoring doubtless took up any spare time which might otherwise have been spent in the study of the countries and the people, but the casual inspection of British territories seems to have left a somewhat unfavourable impression. In any case the descriptions are not valuably informative.

There are some minor surprises, as for instance when one reads that a native from Mombasa is so frightened of the Masai near Kajiado, which after all is not far from Nairobi and on a well-known road, that he will only fetch water from a spring after strong persuasion, or that lions bounded across the veldt with a sound of galloping hoofs. But the book's real interest is the daily life among wild animals, and the photographs of them and of the natives are excellent. E. W. N.

NORTH AMERICA

BOOM IN FLORIDA. By T. H. WEIGALL. *London: John Lane* 1931. 9×6 *inches; 230 pages; illustrations.* 10*s* 6*d*

This extraordinary book gives an account of the great Florida land-boom of the summer and winter of 1925–26 as it appeared to a journalist and adventurer who arrived there with a few dollars in his pocket, and quickly succeeded in becoming actively involved in the seething journalistic, advertising, and real estate life of the place. The picture he paints of life in Florida at the time is vivid and fascinating, with its over-night millionaires and the amazing villas and mansions they built for themselves, its complete suspension of the ordinary sense of proportion and the ordinary rules of business, and the feeling conveyed of the temporary madness of an entire continent. Mr. Weigall's direct, picturesque writing is equal to the formidable demands of his subject, and we can hardly pay him a greater compliment than to say that as we read we believe that even so it must have been. We get a good impression of the personalities of the time, notably of "Doc" Dammers, the irresistible mayor of Coral Gables ("Hey! That'll tell the world what sort of guys we mayors are!"), and Mr. George Merrick, who almost alone among the boosters was passionately in love with Florida, and created Coral Gables after the pattern laid up in his own mind.

They were brave days, and it is a good thing that they have now been recorded in sober perspective. Any one in the least susceptible to the lure of American speed, height, wealth, and energy will enjoy this book, and the most seasoned film-goer will be enabled to add some gems of American idiom to his collection.

D. C. S.-T.

AUSTRALASIA AND PACIFIC

MY SOUTH SEA ISLAND. By ERIC MUSPRATT. *London: Martin Hopkinson* 1931. 8×5 *inches; 256 pages; portrait.* 7*s* 6*d*

The spirit of the stoutest reviewer is daunted when he is asked to review a book called 'My South Sea Island.' When it arrives, and a large photograph of the author is found to adorn both dust-cover and frontispiece, he feels even less inclined for the task. But directly he has surmounted these obstacles and plunged into the book itself, the atmosphere is wholly different. Probably Mr. Muspratt allowed his publishers to arrange the cover and title against his better judgment. For here is a modest account of life in the Solomons as it is actually lived, written easily and in admirably simple English. This is the best modern book on life in the South Seas that the reviewer has read. It was his misfortune recently to have to read a book describing the doings of an American expedition in the Pacific. In that book every little incident was exaggerated in a futile attempt to make it seem exciting. The restraint with which Mr. Muspratt's adventures are described compels admiration. His insight into native character is remarkably shrewd, considering the short time he was among the natives. He neither looks down upon them as "niggers," as do so many ignorant white men, nor extols them for virtues which they do not possess. Mr. Muspratt soon found the value of example in getting natives to work hard; and his physical strength, of which he was justly proud, was here a great asset to him. His delight in getting something done, in improving his plantation, is infectious. While reading, we almost wish we were there to help him clear it of weeds. The character of the manager of the plantation is excellently drawn. We hope to hear more of Mr. Muspratt.

J. R. B.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

HANDBUCH DER EXPERIMENTALPHYSIK. Bd. XXV. Geophysik. Teil II. Physik des Festen Erdkörpers und des Meeres. Edited by G. ANGENHEISTER. *Leipzig: Akad. Verlagsgesellschaft* 1931. 10×7 *inches;* xiv+824 *pages; illustrations and maps. M.*74 (*paper covers*); *M.*76 (*bound*)

The first part of this monumental treatise on geophysics was mainly devoted to atmospheric phenomena and terrestrial magnetism. This, the second, deals with the nature and behaviour of the sub-aerial earth of land and sea. The third, already issued, completes the survey, and justifies its inclusion in a "handbook" of experimental physics by presenting a detailed account of methods of investigation. A comprehensive statement of the position reached to the time of writing in each of a rapidly developing group of subjects is thus made available—at a price. While we cannot but be grateful to the distinguished authors who have so competently "tidied up" these border-line fields of knowledge, and to the publishers whose optimistic enterprise has stimulated them to carry out a gigantic programme with conspicuous success, it is nevertheless plain that there can be but few individuals able or willing to foot the bill. As they stand, these volumes will find a home in few shelves outside the leading reference libraries; yet, if the various contributions had been issued separately, each would have enjoyed a greatly increased sale, and the prospect of this would have made practicable a corresponding reduction in price. The present Part II would make at least five books, each important and complete in itself, and it seems a pity that to study one of these, all five must be paid for or borrowed.

A short but suggestive treatment by Tammann of the geochemistry of the Earth as a whole and of the partition of the elements is followed by an excellent account of radioactivity and geology. The latter, by Kirsch, includes a discussion of the distribution of the radioactive elements and their significance for the Earth's thermal history and the measurement of geological time. The structure and tectonic history of the Earth are admirably dealt with by Kossmat. This section should prove to be of outstanding interest to geologists and geographers, for it gives an illuminating synthesis of the Earth's behaviour and a valuable series of criticisms of current hypotheses. Kossmat presents very convincing evidence against the view that volume changes in the interior, however big, can provide an adequate explanation of tectonic phenomena. While he is sympathetic in his judgment of the Wegener hypothesis, he has no difficulty in showing that as originally developed it is untenable. He does however consider the operation of substratum currents and a certain amount of crustal drift to be implied by the structural patterns of the crust and the changing climates of geological history. In particular he thinks that during the Palaeozoic era the greater proportion of the continents lay in the southern hemisphere and that there has since been a cumulative drift to the north. Now the movement has gone so far that Eurasia may begin to control future geological history by pushing southwards in a renewed effort to reach equilibrium about the equator.

The figure of the Earth, gravity measurements, and isostasy are treated with unusual but welcome detail by Schmehl and Jung. The discussion of gravity anomalies and their interpretation is of particular interest. Full advantage has been taken of the invaluable results achieved by Vening Meinesz, and these and other data are graphically displayed in a series of effective maps and diagrams. Tams provides what is probably the best summary of earthquake phenomena that has yet appeared. With a wealth of illustration he deals in turn with the intensity, geographical distribution, causes, and periodicities of earthquakes. This section is followed by a theoretical treatment of earthquake waves, seismo-

meters and their records, by Meisser and Krumbach. Considerable attention is given to near earthquakes and deep earthquakes, but the application to the structure of the outer shells of the Earth suffers from a defect almost unavoidable in large co-operative books of this kind when rapid progress has been made during the interval between writing and publication.

Rather more than the last quarter of the book is devoted to the physics of the seas and oceans. Defant deals with the physical and chemical properties of seawater, and so leads up to a very fine account of hydrodynamics and their application to the problem of the oceanic circulation. Hopfner concludes with a systematic treatment of waves and tides, tidal theory, and methods of investigation.

The book as a whole contains many weighty and authoritative contributions to the subjects falling within its scope, and as these are so varied it will interest a wide circle of readers. The book is therefore one that should be acquired for all scientific libraries. It has been produced and edited with meticulous care, and its utility has been enhanced by the abundance of its illustrations and by the inclusion of adequate indexes of subjects and authors. A. H.

RHYTHMISCHE PHÄNOMENE DER ERDOBERFLÄCHE. By HENNING KAUFMANN. *Braunschweig: Vieweg und Sohn* 1929. 8×6 *inches;* vi+346 *pages; diagrams. M.*14 (*paper covers*); *M.*16 (*bound*)

This is a curious book. The author has been carried away by an idea and has failed to see its vagueness. The rhythmic phenomena of the book are very varied in character, but agree in showing, more or less definitely, a repetition of similar forms. Amongst them are included sand-ripples and sand-dunes, waves, meanders, and tributaries of a river. The author contends that all are due to one general cause, namely, the relative movement of two media in contact with each other. The media may be solid, liquid, or gaseous, but it is essential that one of them should move relatively to the other. The rhythmical phenomena are attributed to disturbance at the zone of contact. The book is entirely free from mathematics and the author makes no serious attempt to show how the disturbances arise or why they should be rhythmical. He contents himself with vague references to external and internal friction. The bibliography is very full and is the most useful part of the book. The subjects with which the author deals have attracted the attention of mathematicians, engineers, geologists, and geographers. Consequently the literature is very widely scattered, and the author has performed a useful service by collecting the references. P. L.

II JAHRBUCH DES HYDROMETRISCHEN BÜROS LITAUENS. Edited by STEPONAS KOLUPAILA. *Kaunas* 1930. 10×7 *inches;* 376 *pages; illustrations and maps*

The Second Year Book of the Lithuanian Hydrometric Bureau, for the year 1930, is a virtually complete history of the gauging station at Schmalleningken (Smalininkai), on the Memel or Nemuna River, since its foundation in 1811, and is dedicated to the memory of the famous Archduke Vytautas the Great, who died five hundred years ago. The village of Schmalleningken lies close to the former frontier between Russia and Germany, 69 miles from the chief mouth of the river. A temporary gauge-pole was erected in 1811 and was replaced in 1812 by three others, one of them at the landing-stage near a great boulder in the river-bed, on the apex of which a bench mark was fixed. The poles were often destroyed by ice. In 1886–1888 a harbour was built, and as the gauge was enclosed by it at its upper end, it now registered the level of the water at the entrance, 500 metres downstream. At the same time the gauge was rebuilt in its present form of a stairway of four great steps, on the side walls of which the scales were fastened. Six other bench marks were set up and reduced to the precise levelling

carried out in 1895. The annual checks carried out after that date showed a regular sinking during the period from 1895 to 1914, and the records were adjusted accordingly. But the most recent levellings have given the surprising result that the positions of nearly all the bench marks are unchanged, including that on the great boulder, which was the only one in use from 1827 to 1871. The sinkings are therefore believed to be erroneous, but on the other hand it is considered that the observations at Tilsit are open to doubt.

Copious tables and graphs give the water-levels for each day for the period 1812 to 1929, with four lacunae, the most important of which is one of 171 days during the War. The mean monthly level is greatest in April and least in September, with a range of 3·02 metres, and the difference between the greatest and least readings obtained during the period of 118 years is 7·97 metres.

Measurements of the volume of flow in the neighbourhood of the gauge have been made at various times since 1875. For the period 1920 to 1929 the average flow is about 554 cubic metres per second, equivalent to 6·81 litres per second per square kilometre of the catchment area of 81231 square kilometres; in British units, 19565 cubic feet per second, equivalent to 0·0624 cubic feet per second per square mile of the area of 31363 square miles. The average yearly discharge is 17·5 cubic kilometres, sufficient to cover the catchment area to a depth of about 21 centimetres.

The Year Book is partly in Lithuanian and partly in German and is prepared under the instructions of the Director of the Bureau, Professor Kolupaila. Specimens of the original instructions and reports, in German, are reproduced, and also some of the early maps of the neighbourhood. The bibliography at the end is confined to the publications of Professor Kolupaila and of the Bureau; other references are given in footnotes to the text. There are two misprints in the table of units of length on p. 6: the Prussian line and zoll are each 1/12 respectively of the zoll and foot, not 1/2 as printed. D. J. M.

CLIMATOLOGY. By A. AUSTIN MILLER. *London: Methuen & Co.* 1931. 9×6 *inches;* x+304 *pages; diagrams and maps.* 12*s* 6*d*

The book before us aims at providing advanced students, especially students of geography, with a reasoned account of the world's climatic types. The arrangement throughout is not regional but based on climatic types. The classification followed is essentially the same as in other standard works on the subject, sound reasons being adduced for such departures as are made from the usual treatment. The author has taken special care to discuss biological reactions to climate, and the result has been to produce a book which is interesting and stimulating.

The early chapters discuss the elements and factors of climate, leading up to an interesting fourth chapter on the classification of climates. Subsequent chapters discuss in detail different types of climate, such as the equatorial, tropical, tropical monsoon, warm and cool temperate climates, cold, arctic desert, and mountain climates. The present reviewer does not propose to attempt to summarize these chapters in any way, but will content himself with saying that he found these chapters interesting and well informed. A particularly useful feature is the ample provision of references to original papers, both theoretical and statistical.

A few minor points of detail do not appear to be strictly accurate. In Fig. 8, which represents the wind circulation in the troposphere at the surface and at high altitudes, an artificial simplicity is introduced into the upper circulation. Certainly in the summer the circulation at 8 kilometres above the surface still shows considerable deviations from the simple westerly flow indicated in the diagram. Again, in chap. xiv, which discusses mountain climates, an explanation

is given of winds which should blow up mountain slopes during the day. Meteorologists in general do not accept such winds as real, though their counterpart, the flow of cold air down slopes at night, is an accepted fact. These are however but small points in the general argument, and do not detract from the value of the book to most readers.

The author has endeavoured in his last chapter to deal with changes of climates, and has summarized very clearly the generally accepted facts. In connection with this chapter the reader would be well advised to read the report of a discussion on past climates held at the Royal Society, and reported in the *Proceedings of the Royal Society*, B 106, pp. 299–317, 1930. This discussion made it clear that many accepted "hard facts" are not in reality to be accepted as facts.

In conclusion the reviewer has no hesitation in recommending Mr. Miller's book to all students of climatology. It is an extremely creditable production, and its copious lists of references to original sources and well-selected tables of climatological data make special appeal. D. B.

ECONOMIC AND HISTORICAL GEOGRAPHY

SECOND REPORT OF THE COMMISSION ON TYPES OF RURAL Habitation, 1930. *Florence: Union Géographique Internationale* (1930). 10×6 *inches; 92 pages; illustrations and maps*

This second report of the Commission on Types of Rural Habitation, appointed by the International Geographical Union, contains ten papers delivered at the Cambridge Congress in 1928, five of which are in French and five in English. In reading them, reference should be made to A. Demangeon's two articles on "La Géographie de l'habitat rural" in the *Annales de Géographie*, January and March 1927.

Dr. A. Lefèvre ("Classification générale des types d'habitat") criticizes Demangeon's "genetic" classification of nucleated and dispersed rural settlements, based upon type of rural economy for the former, and date of colonization and stage of agricultural development for the latter. The origin and development of agrarian systems are problems which demand long research, and therefore should not be taken as a basis. The preliminary approach to the geographical study of rural settlements should be empirical, and aim at morphological classification based on the character of the distribution of dwellings. Thus, Dr. Lefèvre recognizes three forms of rural settlement: dispersion, agglomeration, and complete concentration.

Half of the volume consists of two excellent articles on rural settlements in the delta of the Nile, and the Beni Suef province of Middle Egypt and the Fayum, by Y. Lozach and G. Hug respectively. The nucleated village is typical in Egypt, and was until recent years virtually the only form of rural settlement. This was due to conditions which necessitated nucleation, the basin system of irrigation, and the selection of sites free from flood, the need for protection from nomad marauders, the system of rural economy and fiscal organization. With changed conditions—the substitution of perennial for basin irrigation and the consequent introduction of new forms of rural economy demanding closer contact with the cultivated land; and the reclamation of land under the control of large landowners, who settle their tenants and labourers in small communities called "ezbahs" near to the cultivated land—there is an increasing tendency to partial dispersion. Thus there are two further forms of rural settlement of recent origin, dispersed and mixed, the latter consisting of scattered farms and hamlets or ezbahs and occasional large villages.

Hug discusses an important problem of population distribution—the dis-

tinction between rural and urban settlements. He suggests an arbitrary population of 10,000 as the most convenient dividing line in Egypt, but recognizes that the distinction is a matter of function and morphology (plan and appearance) rather than population. Urban functions, industrial, commercial, and administrative, are distributed among settlements of varying sizes; a town includes them all, so that the non-agricultural element is dominant. He thus recognizes four types of settlement, towns, rural towns which are local markets, villages, and finally, hamlets or ezbahs, usually colonies of farm labourers established recently by large proprietors.

M. Foncin contributes a masterly study of the settlements of the Maures region of South-East France. The original site and plan of the typical hillside village settlement was due to the exposure of the area to attack by land and sea. But since the end of the sixteenth century comparative security has permitted downhill movement and the growth of new villages and scattered farms on the lowland different in site and form, while in recent years communications have favoured the survival of a few of the latter and the decay of the former. There is a map showing the distribution of nucleated and relatively dispersed settlements in Italy, and a tentative correlation is made between high cephalic index and dispersed settlement, and *vice versa*. The English articles suffer from poor presentation and frequent mistakes of grammar and spelling. Several of the articles would have profited by maps. The population maps of Denmark are drawn on the isopleth method, and this is always open to criticism. Moreover, the scheme of shading in the map showing rural population suffers from the adoption of several colours; different shades of one or two colours would have been much more effective. R. E. D.

INTERNATIONAL MIGRATIONS. Volume II. Interpretations. Edited by WALTER F. WILLCOX. *New York: National Bureau of Economic Research* 1931. 9×6 *inches;* 716 *pages.* $7

The first volume of 'International Migrations,' edited by Dr. Ferenczi, was reviewed in this *Journal* in March 1931. That volume consisted chiefly of statistical tables. This second volume, edited by Mr. Walter F. Willcox, of the Research Staff of the National Bureau of Economic Research, of New York, consists of three parts. Part I deals with the Population of the Earth; Part II with National Immigration Currents; and Part III with National Emigration Currents. The publication of both volumes originated with the Social Science Research Council, which secured the necessary funds for the purpose.

Mr. Willcox himself writes the chapter dealing with the Increase of the Population of the Earth and of the Continents since the year 1650. He points out that estimates of present-day populations are made uncertain chiefly by our ignorance of the numbers of natives of Africa and, perhaps even more, by the difficulty of determining, except very roughly, the population of China. This latter problem is indeed a Chinese puzzle. It is true that in 1910 there was an official return of the number of households, but it is not certain who were included in the household. There was a second return in the following year, but this was left unfinished on account of the outbreak of the revolution. Mr. Willcox gives reasons for adopting a value, based on the return of 1910, of 342 millions, and he compares this with two other estimates, namely, that of the China Continuation Committee of 1922, which gave 375 millions, and an estimate by A. Supan, in *Die Bevölkerung der Erde*, vol. xi, 1901, which gave 330 millions. He finally takes the number 342 millions as probably the best indication of the present population of China. He then corrects two estimates of the total World Population, reducing the numbers given for Asia by the amount of the reduction in the estimate for

China. And, finally, we get for the whole Earth, 1820 millions from the International Statistical Institute; and 1833 millions from the League of Nations. The date of these estimates is 1929, and the mean of the two is 1827 millions. The two estimates in question were made before the publication of the result of the Indian Census of 1931. The total for India was much larger than had been expected, and the present writer would suggest that it may appear necessary to add some 10 millions to the world total, bringing it to 1837 millions. A most interesting diagram is given which shows the growth of the World Population during the last 300 years. Of the total population it is calculated that 642 millions are of unmixed European stock.

The rest of the book is concerned with Immigration and Emigration, and there is much curious and valuable information under both heads. Thus, Mr. Willcox finds that the net total immigration into the United States, from 1820 to 1930, was 26·2 millions, and not 37·8 millions, as had been previously estimated. Much interesting information is given by Mr. R. H. Coats, the Dominion Statistician of Canada, with regard to immigration into that country. It will be news to most people that the Dominion, between 1861 and 1901, lost more people by emigration to the States than it gained by immigration. But from 1901 to 1921 there was a great change. Still, in 1920 there were more than a million Canadian-born in the United States. He points out that British and French "form the basis of the Canadian population, but a basis that is shrinking." The percentage of other stocks rose from 8·3 in 1871 to 16·7 in 1921. In the chapter on Argentina it is shown, amongst other things, that the emigrants into that country are, as to 80 per cent., Italians and Spaniards; and that "immigrants clearly prefer remaining in the cities to going into the country." After chapters on Brazil, Australia, and New Zealand, we reach a long account of Migratory Movements between France and Foreign Lands, contributed by M. Henri Bunle. Leroy-Beaulieu (1886) is quoted to the effect that "France is quite as much an immigration country as Argentina or Australia." In 1911 the census showed over a million foreigners living in France. Between 1921 and 1926 the net immigration was about 730,000. In 1927 the number of alien wage earners was about a million. "When the armistice came, the able-bodied French population had been diminished by 1,250,000 killed, and by about as many wounded." In the growth of France's population immigration has played a significant rôle. The share of net immigration in the increase between the last two censuses attained 74 per cent., an increase due largely to the loss of Frenchmen during the World War.

In the chapter on Italian Migration it is stated that during the post-war years there was an increasing volume of migration from northern Italy to south-western France. In the years 1922–25 this averaged 173,000 a year, and the emigrants were mostly farm labourers and their families. In 1926 it was calculated that over 900,000 Italians were residing abroad. There is a chapter, fifty pages long, devoted to the Emigration of the Jews. Another, sixty pages long, deals with Russia. It is remarked that emigration from Soviet Russia is not likely to be heavy. "The villages are over-populated, but the superfluous labour flows thence into the cities."

In the chapter on Indian Migration, by Mr. G. Findlay Shirras, it is stated that, about 1921, there were some 2¾ millions of Indians living abroad. In Ceylon 14 per cent. of the entire population consists of Indians born in India. Much valuable information is given with regard to the status of Indians in other parts of the Empire. This has been greatly improved in recent years, largely owing to the efforts of Mr. Sastri. The chapter on International Migration of the Japanese was written by Mr. Yamato Ichihashi. He remarks that "Of late . . . both the government and the thinking public in Japan have been agitated over the problem

of population, and the government has instituted a Commission of Population and Conservation." He points out that Hawaii is no longer a field for Japanese immigration. As to the Philippines, "There is every indication that the Philippine Islands will not attract Japanese emigration." The same thing is said about Mexico. But Brazil may be considered the most important field for Japanese emigration. "Asiatic Russia is not an attractive field . . . certainly it does not invite Japanese labourers." "Australia is a closed field for Japanese emigration." The author of this chapter looks upon emigration, under these circumstances, as no solution of Japan's population problem.

All who study population questions will find much to interest them in this book. It has only been possible, in this notice, to touch upon a few of the matters dealt with. C. F. C.

THE TRAVELS OF AN ALCHEMIST: the Journey of the Taoist Ch'ang-Ch'un. Translated by ARTHUR WALEY. (The Broadway Travellers.) *London: George Routledge & Sons* 1931. 9×6 *inches;* xii+166 *pages; map.* 10*s* 6*d*

Ch'ang-Ch'un is so little known in Europe that though his travels are far less important in every way than those of his Buddhist predecessor, Hsüan-Tsang, it was an excellent idea of the editors of the Broadway Travellers to include him in the catholic range of their protégés. Even more fortunate was their choice of translator and editor, for Mr. Waley has not simply reproduced the senescent Russian translation by the Archimandrite Palladius, but has gone direct to the original sources and has utilized the works of both Chinese and (what is just as important) Japanese commentators.

It was early in 1220 that Ch'ang-Ch'un set out from his home in Shantung at the summons of Chingiz-Khan, whom he met at length in Afghanistan in May 1222, and he returned thence to Peking, which he reached in the spring of 1224. The story is naturally focussed upon the personality of Ch'ang-Ch'un, and the human interest of his travels lies more perhaps in this suggestive association of conqueror and sage than in the spare and unemotional narrative of the chronicler, who himself accompanied him throughout. Nevertheless there is much of both cultural and geographical value contained in his laconic phrases. Mr. Waley has approached his text rather from the literary than from the geographical side, and his footnotes do not always elucidate the vague references in the itinerary of the travellers. The map too is definitely unhelpful; despite the apology contained in the preface, it would surely have been possible to insert more detail of the route, or at least a larger number of place-names. The distances are given throughout in *li*, which by an unlucky misprint is evaluated at "3½ miles" (p. 63, n. 3) instead of "3½ *li* to the mile," thus putting the unhappy alchemist to the inconvenience of covering such prodigious distances as 1000 miles in thirty-six hours (pp. 127–8). Apart from one or two such inconsiderable slips, Mr. Waley's version marks a very great advance on anything that has hitherto been accessible to Western readers. The detailed introduction which he has supplied throws a flood of new light on the Taoist background of the travels, and it would be superfluous to praise the English style of the translation itself. H. A. R. G.

GENERAL

IL CAMMELLO ED I REPARTI CAMMELLATI. By MASSIMO ADOLFO VITALE. *Rome: Sindicato Italiano Arti Grafiche* [N.D.]. 10×7 *inches;* 294 *pages; illustrations and diagrams. L.*25

This book, published under the auspices of the Italian Ministry of the Colonies, is a welcome addition to the scanty literature of the camel and a complement to Lesse's exhaustive 'Treatise on the one-humped Camel' (see *G.J.*, vol. 72, page

183) which was based mainly on Indian experience. The author has a wide knowledge of his subject gained as a Camel Corps officer in Tripolitania and later as an administrative official in Eritrea. Chapter I, after a list of historical references to the camel, gives details of its use in more recent military operations, particularly by the Italians and French in North Africa. Three chapters are devoted to a description of the camel's anatomy, types, breeds, etc. The remark, in the section on camel brands, that "the theft of camels is rare" will make some District Commissioners of camel-owning tribes long for a transfer to the author's locality. Chapter V deals with camel ailments, their prevention and cure. A further section of the book gives excellent practical advice on a subject of special importance to the ordinary user of camels, *i.e.* their treatment on the march and in camp, grazing, watering, loads, distance covered daily, etc. The last three chapters treat the subject mainly from a military standpoint, though the notes (pp. 249 ff.) on the various types of saddle are of general interest. A fuller index would have been an advantage, also a few more illustrations of camel types. Perhaps the chief fault of this useful book is that it is not available in English! W. B. K. S.

TRANSLITERATION [ARABIC—HEBREW—ENGLISH] WITH Transliterated Lists. *Jerusalem: Government of Palestine Printing and Stationery Office* 1931. 8×5 *inches;* iv+85 *pages.* 50 *mils*

This very useful compilation comprises transliteration systems from (1) Arabic into English, (2) Hebrew into English, (3) Arabic into Hebrew, (4) Hebrew into Arabic, and lists of (1) 250 Arabic, (2) 200 Hebrew personal names transliterated into English, and (3), last but not least, some 1200 geographical names in Palestine in English, Hebrew, and Arabic. It is satisfactory to find the R.G.S. II systems for Arabic and Hebrew commended in the introduction and adopted almost entirely as the official methods. The chief difference is the rendering of the Hebrew letter *zadei* here by *ts* in accordance with local pronunciation, but in R.G.S. II by *z* as the conventional form: *e.g.* Mizpa, Ziyon, pronounced Mitspa, Tsiyon; while *th* is not here recognized as a Hebrew form, *t* being substituted: *e.g.* Beit Lehem.

The official Palestine 'System of Transliteration from Arabic into English,' published in 1923, has evidently been superseded. By its rules the article was to be invariably "al," now "el" (rarely "al" and then for no apparent reason), and the terminations "-eh" and "-ia" were allowed, now "-a" and "-ya." The question of *a* or *e* for the Arabic vowel *fat-ha* is always troublesome. The present official system is wisely not committed to one or the other, though on the whole favouring *a*: *e.g.* Bani, Khirbat, Majdal, Mazra'a, Nabi, Tall; but it prefers *e* in the article and in the diphthong *fat-ha ya* even to the extent of writing " 'Ein." One excellent feature is that the vowel-points are shown in both Hebrew and Arabic scripts. In the English forms the long vowels are marked, and occasionally the stressed syllable is accented. A few conventional names are allowed, like Acre, Bethlehem, Gaza, Hebron, Jaffa, Jerusalem, Jordan, Tiberias; but Beersheba, probably only by accident, does not appear in the list in any form. It is amusing to find Neuhardhof solemnly transliterated into Hebrew and Arabic. Balfuriya looks decidedly more oriental than the old spelling Balfouria. J. H. R.

THE MONTHLY RECORD

RECENT JOURNEYS IN THE YEMEN

A French traveller, M. Pierre Lamare, was able to make two journeys into little-known parts of the Yemen during 1929. He describes the itineraries in *La Géographie* (November–December 1929 and January–February 1930), and, with information gathered on previous visits, attempts a regional division of the Yemen. The first journey was made to the mountain complex around Kohlan and Hajje, about 100 km. north-west of San'a: the second to the upper valleys of the Wadi Bana, 150 km. to the south-south-east. Two of these valleys, the Khoban and Shalala, do not seem to have been described, and M. Lamare makes several corrections to existing maps of this region. The general appearance of the northern region is comparable to that of the "Causses" of the Tarn, though on a much greater scale. It is considered by the local inhabitants to be the highest part of the Yemen; he estimates that the crests rise to 3500 metres. The whole area has been strongly denuded: the wadis, with precipitous sides, emerge from great cirques. The sides are barren, in contrast to the heavily vegetated water-courses. Two features add to the strangeness of the landscape: the fortified dwellings perched upon the least accessible crags, and the extensive system of terrace-cultivation. In extreme cases, slopes with an angle of 60°–70° are terraced, if good water is available. Coffee, *qat*, and cereals are grown in the irrigated valleys. Below 1500 metres, the coffee plants are shaded from the sun by trees. M. Lamare's vivid description makes it easy to understand how this region has always been the centre of resistance to invaders.

M. Lamare's second journey was through a region of contrasted features. The Wadi Bana is the sole river which carries the run-off from the interior plateau to the Gulf of Aden. Its fall, in its upper course, is small and constant: its bed, unlike a "wadi," lies between definite banks, water plants and fish testify to permanent water, and its valley is a true plain. He believes it to be the remnant of the drainage system which existed before the formation of the Red Sea trough. From his observations, he suggests that the "W. Shalala" of the Taiz sheet of the G.S.G.S. 1: 253,440 map of South-West Arabia is really the Wadi Khoban, and that the course of the Shalala is not shown upon it; he also corrects slightly the course of the Wadi Bana. In the latter part of his paper he criticizes previous regional classifications of the Yemen, particularly that advanced by Herren Rathjens and von Wissmann (see *G.J.* 75, 1930, pp. 203–04). He believes that they, and other visitors to San'a, coming by the Hodeida road, have been unduly influenced by the quite unnecessary ascent and descent of the Jebel Harraz, which has led them to consider it to be a true mountain range, whereas it is merely an isolated massif, without general significance. The sole tectonic feature of the Yemen is the high plateau which has resisted all disturbances. The valley of San'a is not tectonic in origin, nor are the summits which border the western edge of the high plateau. Being simply eroded from horizontal series, they should not be regarded as "horsts." Thirty to forty kilometres beyond the plateau-edge the level of the underlying granites and schists has not varied. Taking into account the facts of botany and human geography, he proposes five main divisions: the coastal Tihama; the interior Tihama (in accordance with local usage M. Lamare applies this term more extensively); an intermediate zone (800–1700 metres); the slopes of the great mountain massifs (divided into two sub-sections, 1700–2400 m., 2400–3500 m.); the high plateau, differentiated from the preceding zone solely by its morphology. The characteristics of each of these zones are then described in detail.

STRUCTURE OF EASTERN ASIA

In a paper on The Rocky Mountain Arcs in Eastern Asia (*Journ. Fac. Sci., Imp. Univ. Tokyo*, section II, vol. iii, pt. 3, pp. 131–183) B. Koto endeavours to trace into Asia the different elements of the Rocky Mountain System of America. So little is known about the geological structure of Eastern Asia that such an attempt cannot be more than tentative, and the author is compelled to rely largely upon topographical rather than geological considerations. Some of his conclusions differ essentially from those of previous writers. The Tsinlingshan and the Hwai Mountains are usually recognized as the continuation of the Kunlun, but Koto thinks that the system may be traced still farther, into northern Kyushu and thence into the main island of Japan, finally terminating at the "Fossa Magna" of Naumann. He draws attention to an important structural line which, upon his map, runs from the mouth of the Yenisei through Krasnoyarsk and past Lopnor to the Gulf of Martaban and the Malay Peninsula. He suggests a mountain-trend in the Pacific running from Hokkaido through the Hawaiian Islands to the Andes of Ecuador.

THE GEOLOGY OF THE SAHARA

During his journey across the Sahara, Captain D. R. G. Cameron collected a number of geological specimens which have been described by Dr. Ethel Currie, of the Hunterian Museum, Glasgow University, in a paper (*Geol. Mag.*, vol. lxviii, August 1931, pp 363–6) which may be regarded as a technical appendix to Captain Cameron's account of the journey published in this *Journal* (vol. 71, pp. 538–559). His book 'A Saharan Venture' (1928) describes the journey in more detail. The collection consists mainly of pebbles, so that the site of the rocks may be at some distance from the line of route; but in such country as the Sahara pebbles are often particularly instructive, as they represent the hardest and best preserved of the local rocks and are in better condition for study than the weathered material which is often alone exposed *in situ*.

The rocks collected were obtained from five areas on a roughly S.–N. route between Kano and Algeria, passing east of the Ahaggar Massif. The main geographical interest of the collection and of Dr. Currie's paper is in the evidence afforded regarding the route of the connection of the Cretaceous sea of the Lower Niger and West Africa with that of the Mediterranean and Algeria and Tunisia. Captain Cameron's most important specimens are from areas between the French stations, Fort Charlet and Fort Flatters, areas from which only pre-Palaeozoic and Palaeozoic rocks had formerly been recorded. Certain specimens from these areas collected by Captain Cameron are identified by Dr. Currie as belonging to the Upper Cretaceous series found by Mr. F. R. Rodd in the neighbourhood of Milen and Tin Wana, Captain Cameron's most southerly collecting area (see J. W. Gregory and E. D. Currie, *Quart. Journ. Geol. Soc.*, lxxxvi, 1930, pp. 399–403). Between Fort Charlet and Fort Flatters Captain Cameron also found specimens of limestone, probably identical with that in which Mr. Rodd collected the Turonian fossils described by Dr. J. Weir (*Quart. Journ. Geol. Soc.*, lxxxvi, 1930, pp. 404–7, pls. xxxvii–ix).

The connection of the middle and upper Cretaceous rocks of Angola and Southern Nigeria with those of Algeria and Tunisia by a trans-Saharan route is of importance for its bearing on the history of the Atlantic Ocean. An arm of the sea passing from Tunisia southward between Ahaggar and Lake Chad and continuing southward as the Angola Gulf down the Lower Niger to Angola was put forward as the probable route by Professor Gregory in 1922 in his sketch-map (*Trans. Roy. Soc. Edinb.*, liii, p. 161). Subsequently it was suggested that the route was possibly to the west of the Ahaggar Massif (Gregory and Currie,

1930, *loc. cit.*, p. 403). Captain Cameron's collection shows that the route indicated in Professor Gregory's 1922 map was certainly in existence although the Cretaceous sea may have extended also to the west of Ahaggar. In either case it is unnecessary to assume the existence in Cretaceous times of a continuous sea along the present Atlantic to the west of northern Africa to explain the passage of the Mediterranean marine fauna to Angola.

HAMITIC INTRUDERS IN THE AFRICAN LAKE REGION

The latest contribution to this much-discussed question is a paper by Mr. J. H. Driberg, of which a reprint has been received, taken from a German serial of which the title is not given. While Speke and other early travellers thought the dominant class in the inter-lake kingdoms to be Galla in origin, this view has been questioned of late years, and some writers have even placed the original home of the immigrants in the north-west. Mr. Driberg believes not only in a north-eastern, but in a Galla origin, and endeavours to trace the route by which the northerners arrived, deducing this from the distribution of Hamitic culture in the area occupied by them. The generally held view that they came directly from the north-east is inconsistent, he holds, with the intensification of the alien culture in the south-west—Burundi, Ruanda, and Ankole—as compared with the eastern kingdoms of Buganda and Bunyoro. He shows that the name applied to the original kingdom, Kitwara, is to be traced in *awatwara*, even now the designation of provincial governors among the Barundi. He gives reasons for holding that the Hamite dynasty in the Eastern kingdoms is more recent than in the south-west, the earlier kings spoken of in the native traditions of the former being pre-Hamitic. For reasons which cannot be entered into here, and which are no doubt highly speculative, Mr. Driberg takes the Galla due west along the fifth parallel to Mongalla on the Upper Nile, the route then leading up the valley of the river and west of the lakes of the Central Rift Valley, until it finally turns north after making the circuit of Lake Kivu; the final dispersion taking place from a centre in Ankole. It is claimed that the route predicated, leading through the present country of the Bari on the Upper Nile, would throw considerable light on the difficult problem offered by those people, with a culture decidedly Western, but a language distantly related to the Nilo-Hamitic group. Mr. Driberg recognizes that objections are likely to be raised to his theories, and endeavours to meet these in advance.

THE RÉGIME OF THE MISSISSIPPI

Through the activities of various official departments of the United States, maintained for a number of years, a body of data regarding the régime of the Mississippi has been brought together which is not to be matched for any other of the great rivers of the globe. But the very amount of the material renders it unmanageable, and students will be grateful to M. Maurice Pardé for what is no doubt the most satisfactory résumé of the main features of the Mississippi régime that has yet appeared (*Revue de Géog. Alpine, Grenoble*, Fasc. 4, 1930). M. Pardé is known for his admirable studies of the régime of the Rhône and other French rivers, and no one more competent for the task could be found. He has not only made a profound study of all the published material, but where any gaps existed, has filled them by correspondence with responsible officials, who have made available to him data not accessible to the general public. He deals with the river from every point of view, discussing first the geographical and meteorological factors in play, coming then to the discharges of the river as a whole and of its component parts, and their seasonal variations, and ending with an intensive study of the floods to which the basin is liable. Throughout he makes instructive comparisons with European rivers.

Draining a vast and generally level plain, the Mississippi feels the influence of mountains only on the east and west borders, and even on the side of the Rocky Mountains snowfall plays a far smaller role than in the Alps. The inclination of the river-beds is generally moderate. But the mere size of the basin produces marked differences. Relatively to the areas drained, the volumes discharged are nowhere so high as in the Alps or Pyrenees, largely by reason of the greater evaporation, due to the lower latitude. That of the Missouri is meagre, of the Mississippi only moderate, but of the Ohio considerable. Subject to rainfall of oceanic type, the Ohio is high in winter. A continental type with double maximum brings high-water in summer in the west and north-west, but whereas the chief rise is in April on the Upper Mississippi, on the Missouri, more affected by snow-melting, it is in June. Below the Ohio the main river combines the two elements, as does the lower Rhine. In the north-west the lowest stages are in winter, in the autumn or late summer elsewhere: they are most serious on the Missouri and Arkansas. The relative maxima are scanty on the Missouri, nothing remarkable on the Mississippi, imposing on the Ohio, enormous on the Miami and Appalachian tributaries. In the west the rivers overflow in the hot season, in the east in the cold, in the south from January to August; the lower main river being dangerous from January to May. Certain local floods have a destructive violence due to rains more torrential than fall in Europe at an equal distance from the sea. Floods due to a single deluge are more disastrous than in France or Germany, especially on the Ohio, and these absolute maxima contradict the mediocrity of the relative discharges, making of the Mississippi an organism of a power unknown in Europe.

OUTLET OF CHRISTCHURCH HARBOUR, HANTS

In January last Mr. E. St. J. Burton read a paper before the Geologists' Association on "Periodic changes in position of the Run at Mudeford," which is printed in Part 2 of the Association's *Proceedings* for 1931. The final outlet of the combined waters of the Stour and Avon, which have expanded into the mile-wide water-surface of Christchurch harbour, is a striking instance of the deflection of a river-mouth under the action of waves and currents, which, in its broad features, is easily explicable by the configuration of the coast, with the sudden change of direction at Hengistbury Head, which allows the formation of a shingle spit on the lee-side, given the prevalence of winds and waves from the south-west. But certain details are less easily explained, and are discussed at some length in the paper. It is supposed that the combined rivers once entered the sea close to the eastern foot of Hengistbury Head, for the view held by some that the Stour flowed out south of the Head seems without foundation. The writer suggests that the spit must have been initiated by increased erosional activity in the west. (Would not the process begin in any case when once the present outlines of the coast were established?) The extension of the spit seems to be periodic. It may be temporarily prolonged to a point opposite Cliff End, but is liable to be broken through opposite Mudeford, nearly a mile nearer the starting-point, such a break occurring during the rare combination of a very heavy south-east gale with spring tides. Mr. Burton refers to various old charts as indicating conditions at different times, but until quite recent times no great trust can be placed on such conclusions. About 1847 there seems to have been an outlet at Mudeford, but by 1870 the spit had reached Cliff End. A break occurred again in 1883, but in the next ten years there was an advance of two-thirds of a mile. A new break occurred in 1911, and one seems to have been narrowly escaped in September last. The lateral movement of the "Run" is also discussed. A lagoon on the landward side seems to represent a former course, but its channel has

been almost entirely masked by shingle deposited during south-east gales. Mr. Burton considers that the channel would naturally be shifted outward with each periodic change, and seems puzzled by the tendency of the Run to press against the northern shore. If however the spit moved outwards, would not the protection afforded by Hengistbury Head be lost to some extent? A speaker after the paper, Mr. H. W. Pitt, laid stress also on the action of opposing but juxtaposed tidal currents, which would favour an S-shaped bend at the mouth of the Run.

THE NORTH SEA EARTHQUAKE OF JUNE 7

At about oh. 26m. (G.M.T.), a rather strong earthquake was felt over an unusually great area in this country and on the continent, including about 15,000 square miles in Scotland, and about 45,000 square miles in England and Wales, the only English counties undisturbed being Cornwall and Devon. On the continent the shock was felt from the southern end of Norway to Paris, and, towards the east, at Amsterdam. Thus, the whole area disturbed must have been more than 250,000 square miles, or greater than that affected by the Riviera earthquake of 1887. In this country the shock was strong enough to cause slight damage, such as the fall of a few chimneys at Filey, Bridlington, Beverley, and Hull in Yorkshire; some of the cracks in the chapter-house at Lincoln were widened; and chimneys fell at Wighton, near Wells, Sheringham and Cromer in Norfolk, and at Lowestoft and Oulton in Suffolk. The forms of the curves bounding these places and the disturbed area in Great Britain show that the centre must have been far out in the North Sea, and the Rev. J. P. Rowland, S.J., has shown (*Nature*, vol. 128, pp. 147–148), from the examination of the records obtained at twenty observatories, that the epicentre was situated in lat. 53° 57′ N., long. 1° 25′ E., or about 70 miles east of Hornsea in Yorkshire, the time at the origin being oh. 25m. 24s., G.M.T. There is no certain evidence of the occurrence of any earthquake in this centre during the whole duration of our earthquake record, or indeed for nearly one thousand years. C. D.

COMMISSION ON PLIOCENE AND PLEISTOCENE TERRACES

The report of the President of the Commission on Pliocene and Pleistocene Terraces has just been issued (Professor E. Hernandez-Pacheco, "El Problema de las Terrazas Pliocenaz y Pleistocenas en 1931." *Madrid: Soc. Geogr. Nacional* 1931), and will be presented at the Geographical Congress in Paris this month. It summarizes the conclusions of the Commission published in the First (1928) and Second (1930) Reports and embraces an interim report prepared within the Commission last December. It also takes into account much information collected more recently. Since it went to press a considerable number of communications have been notified, and they will be read at the Paris meeting, with the President's report as a starting-point. The Commission will find its time fully occupied.

The classification suggested in 1928 (*G.J.*, vol. 72, p. 461), *i.e.* the "zoning" of terraces into mountain-building-and-volcanic, "eustatic," and isostatic provinces, has maintained its value in subsequent work. The eustatic zone of the Atlantic coast of France and of the major part of the Mediterranean may prove to be a part of a wider province embracing a great length of American and African coast-line, though some authors are bolder than others in taking this for granted. It is hoped that some recent work on the Pacific littoral will be available at the Paris meeting.

Authors' views on the causes governing the formation of terraces differ appreciably: many place their faith in eustatic processes, with variants; some

favour a more dynamic mechanism. Perhaps it is fair to say that such views are influenced inevitably by the zone in which an author has done most work. At least the notably step-like arrangement of terraces has led to a widespread recognition of phases of the active functioning of the causes of terraces, whatever they are, alternating with periods of cessation (except in certain regions). It remains however to fix precisely any one constant level, or horizon of inconstant level, of undoubtedly the same age over a wide area. In this, notable advances have been made. It remains to be seen what the Congress will produce. K. S. S.

AUTHORSHIP OF THE EBSTORF MAP

The two most imposing specimens of medieval cartography that have survived are no doubt the Hereford and Ebstorf maps, which surpass all competitors in size and wealth of detail, so that, in spite of their crude conceptions of geography, they are worthy of the closest attention. The Ebstorf map (so called from its discovery in the early nineteenth century in the convent in that place, which lies between Hanover and Lüneburg) bears no author's name—at least none decipherable in the present condition of the map—and no attempt was made by the editors of the two existing facsimiles, Sommerbrodt and Konrad Miller, to guess at its authorship. The task has now been attempted by a modern German student of early maps, Richard Uhden, in the *Jahrbuch* of the Geographical Society of Hanover for 1930. This writer believes that the author was no other than the Englishman Gervase of Tilbury, author of the 'Otia Imperialia,' and though he makes no claim to have definitely proved his case, the grounds for his view seem plausible and worthy of consideration. That the 'Otia' (which actually refers to a map made by its author) was one—and that the latest—of the sources drawn upon was recognized by both Sommerbrodt and Miller, but as the latter put the date of the map as after 1270, whereas Gervase had reached manhood well before 1200, there could be no question of his authorship if Miller's dating had been correct. Uhden therefore begins by putting forward reasons for placing the map in the first half of the thirteenth century, probably about 1235. He quotes evidence from old records that a certain Gervase was Provost of the Monastery at Ebstorf between 1223 and 1234, and also a statement that in 1229 this Gervase was sent on a mission to King Henry of England.* Now, besides being English by birth and in favour at the English Court, Gervase was a protégé of the German Emperor Otto IV, to whom in fact he dedicated the 'Otia,' which he sent to him through a friend at Hildesheim (1214 or later). There is therefore nothing incongruous in the supposition that it was he who acted as envoy. If he was really the author of the map we should have an explanation of the otherwise surprising fact of the production of such a monument at a place not noted in those days as a seat of learning, and in a part of Europe from which emanated no other early geographical document of importance. The writer sums up his argument as follows: The Englishman Gervase of Tilbury was in the German Emperor's service in the first quarter of the thirteenth century. He was author of a historico-geographical work in which mention is made of a world-map. Lastly, he disappears from view in a part of Germany where a certain Gervasius is known to have held office between 1223 and 1234, and where six hundred years later a world-map was discovered to which no other writer of the time stands in so close relationship. The presumption therefore is held to be that he was its actual author.

*The envoy is spoken of also as Galfridus, but Uhden shows reason for thinking either that there was some motive for keeping his true name secret, or that Gervase used the name Galfrid (Geoffrey) sometimes as a *nom de plume*.

EMPIRE SURVEYORS' CONFERENCE, 1931

The Second (and now, it is hoped, Triennial) Conference of Empire Surveyors took place this year from July 8–28 under the chairmanship of Brigadier H. St. J. L. Winterbotham, for whom Colonel M. N. MacLeod occasionally acted as deputy. Most of the meetings in London were held by the courtesy of the Director, Sir Henry Lyons, at the Science Museum, where Sir Ernest Dowson had assembled a number of exhibits to illustrate the chief subjects before the Conference, cadastral survey and land registration. Other meetings, at which geodetic and general survey were considered, were held at the Surveyors' Institution, Admiralty, and War Office. Short visits were paid to Cambridge, Greenwich, and Southampton; and there was a longer excursion to Liverpool, York, and Hull, winding up with a trip on the North Sea for the inspection of hydrographic methods. Hospitality was offered to the Delegates by Sir Gerald Lenox-Conyngham at Cambridge, by Messrs. Cooke, Troughton and Simms at York, and by this Society at an evening reception on July 27, when the guests were received by Colonel Sir Charles Close in the regretted absence of the President. Official functions included an afternoon reception at Hampton Court Palace given by the War Office, luncheons at Greenwich Observatory and in H.M. Surveying Vessels given by the Admiralty, and at the Ordnance Survey by the Ministry of Agriculture and Fisheries, and a dinner at Lancaster House given by the Colonial Office. The arrangements for the Conference were in the hands of Captain G. T. McCaw and Mr. E. B. Bowyer, joint secretaries of the Colonial Survey Committee, assisted by Captain M. Hotine. It is anticipated that the *Proceedings* will be published early next year, when there will be an opportunity of reviewing the work of the Conference in detail.

EMPIRE SURVEY REVIEW

In 1905 Mr. (now Sir Herbert) Read, of the Colonial Office, and the then head of the Geographical Section of the General Staff, War Office, recommended to their respective Government Departments the formation of a committee to exercise a general advisory supervision over the work of the survey departments of the Crown Colonies and Protectorates. This suggestion was approved, and the Colonial Survey Committee came into existence and has continued its useful functions to this day. An off-shoot of the work of this Committee has been the assembling, at the invitation of the Colonial Office, of the Conference of Empire Surveyors in 1928 and again this year. Another useful outcome of the work of this Committee, due to the initiative of Brigadier H. Winterbotham, is the publication of the *Empire Survey Review*, of which we here welcome the first number.

The *Review*, in its present form, is a pamphlet of forty-eight pages. It opens with a foreword by Sir Cecil Bottomley, the Chairman of the Committee. There are articles on Primitive Landmarks and Maps by Mr. O. G. S. Crawford; Tertiary Bases by Dr. de Graaff Hunter; the new Ordnance Survey Map Mounting Machine by Captain D. R. Martin; Portable Standard Compasses by Mr. T. F. Connolly; Laplace Azimuths by Captain M. Hotine; Simple Resection by Mr. A. E. Thomas. These are followed by reports on The Hydrographic Year by Admiral H. P. Douglas and on work on the Gold Coast by Mr. J. Clendinning, and by reviews and notices. Admirable mixed fare; some of the articles are of real technical importance.

The *Review* covers a new field; it will be a vehicle for the publication and distribution of both new technical discoveries and methods, and also of reports on the progress of the Surveys of the Empire. The editing is in the very competent hands of Captain G. T. McCaw. We welcome the appearance of this new journal and predict an important future for it. C. F. C.

OBITUARY

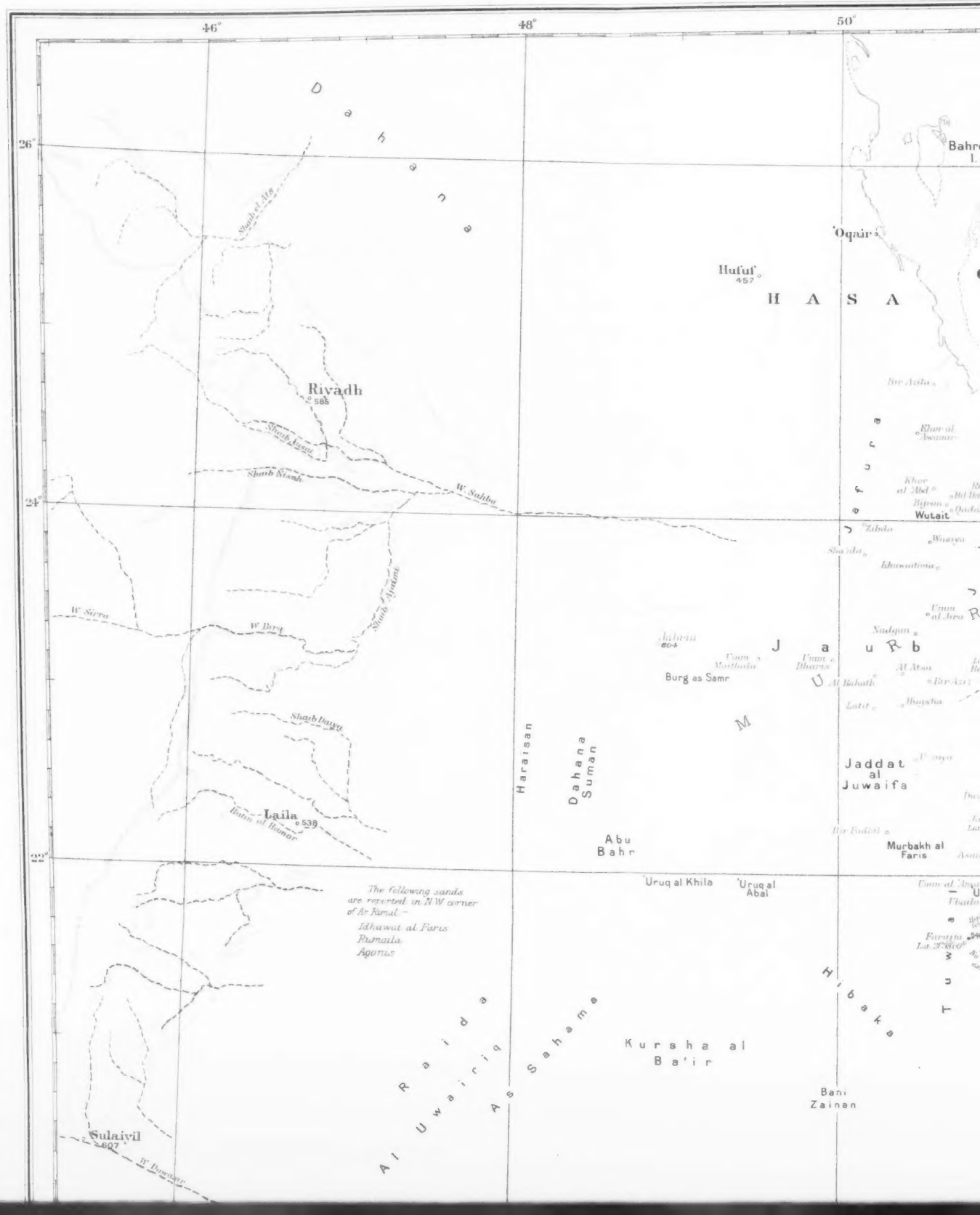
LIEUT.-COLONEL HENRY TREISE MORSHEAD, D.S.O., Survey of India

Colonel Morshead was murdered in the jungle near Maymyo on the morning of 17 May 1931 during an early Sunday morning ride, and the murderer has not been brought to justice. This unexplained crime has robbed the Survey of India of a very able and gallant officer well remembered in our Society by the part he played on the first and second Mount Everest expeditions. But he had earlier claims to our regard as an explorer and geographer. Having, after some three years' service in India, been posted to the Survey, he devoted his leisure to a thorough study of Himalayan and especially of Tibetan exploration, and learned the Tibetan language, so that when after the Mishmi Mission had given him his first experience of survey in unknown mountain country he was employed again under Captain Gunter in the following winter of 1912–13 on the Mishmi Exploration survey he soon made his name. Morshead and Oakes discovered the great peak Namcha Barwa in the bend of the Tsangpo; and in 1913 Bailey and Morshead made their celebrated exploration of the Tsangpo gorge, which proved the identity of the Tsangpo with the Brahmaputra, and destroyed the theory that there were great falls on the Tsangpo. For this frontier work he received the thanks of the Government of India and was awarded the Macgregor Medal.

Then came the War and long service in France in command of the Royal Engineers of the 46th Division; he was promoted Major in December 1916, wounded in September 1917, twice mentioned in despatches, and awarded the Distinguished Service Order. Soon after his return to service in India he was able to join Dr. Kellas in an attack on Kamet, and learned the technique of mountaineering from a master of the art, so that his claim to command the Survey of India detachment that accompanied the Mount Everest Expedition of 1921 was indisputable. Leaving to Wheeler the detailed survey of the immediate mountain area, he set his native plane-tablers to cover a wide range of unexplored Tibet, doing no triangulation, but utilizing the peaks intersected by Ryder on the Tibet Mission of 1903–04. The result was not without defects, for Morshead was during much of the time with the climbers who went the long way round by the Kharta glacier to the Lhakpa La, though he was not one of the three who descended thence across the head of the East Rongbuk glacier and gained the Chang La or North Col.

In the following year he obtained leave and went as one of the climbing party, reaching Camp V. with Mallory, Norton, and Somervell, and there, by a light-hearted neglect of precautions, getting the frost-bite which cost him three fingers of his right hand, and made it impossible for him to be chosen as a climber for the third expedition of 1924; and he could not be spared from the Survey to go as transport officer and interpreter as he longed to do. But his ardent spirit led him on his next leave home to accompany as surveyor the expedition of young Cambridge men to Edge Island, led by Mr. Watkins in 1927.

He was a man of great physical strength and endurance, quite regardless of personal comfort, of dauntless resolution, courage, and enterprise, whose fate is mourned alike by his brother officers of the Survey of India and the friends old and young who were his comrades in exploration.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Abal
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Faris
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Shaib Nisah
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W. Birq
Shaib Ayaam
Shaib Dauya
Batn al Rumar
W. Bawtaar
Shaib el Ahs
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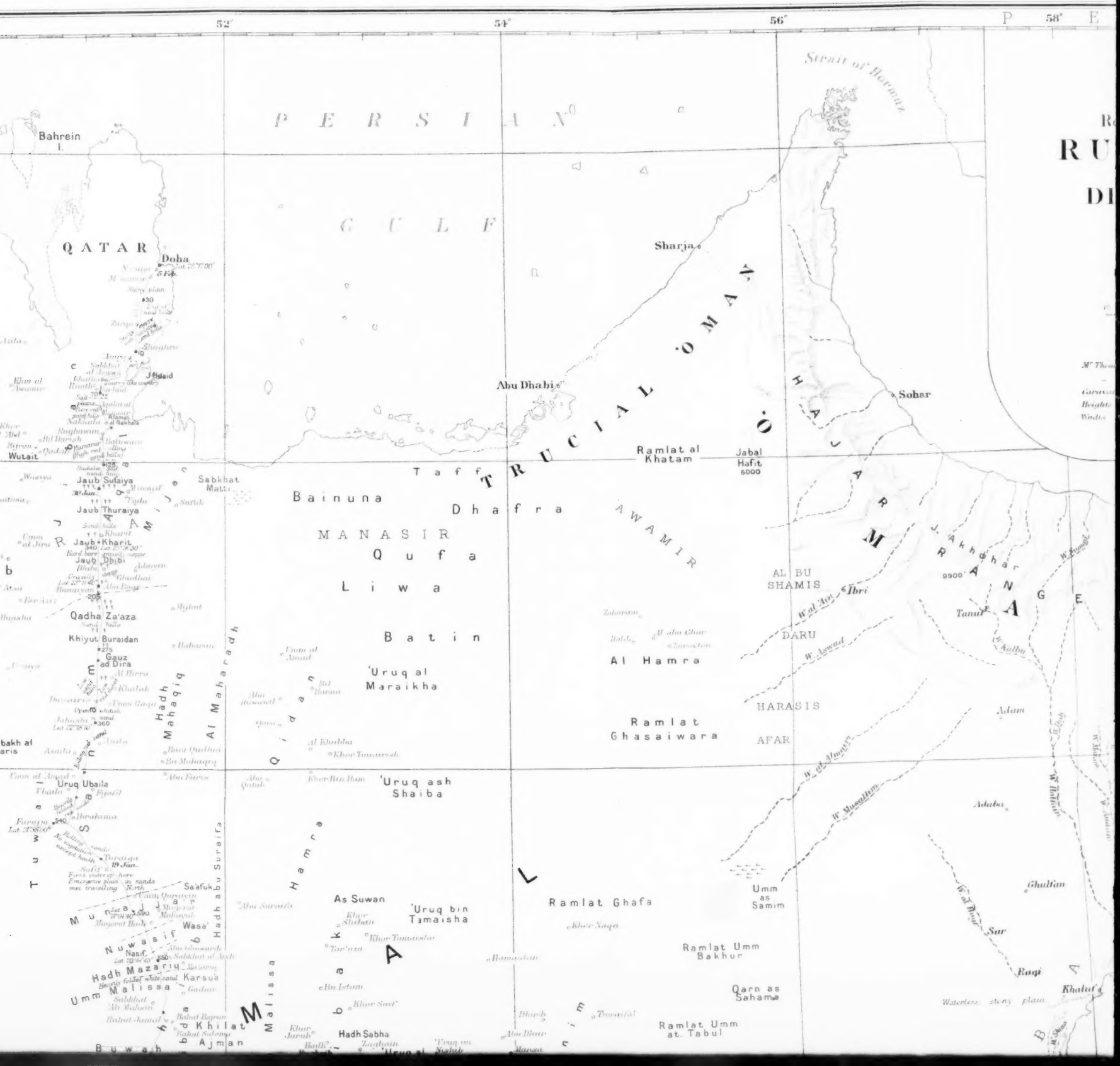
are reported in N.W corner
of Ar Rimal –
Idhawat al Faris
Rumaila
Agonus
Al Uwairiq
Ar Raida
As Sahame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Al Maharadh
Qidan
'Uruq al Maraikha
Al Hamra
Ramlat Ghasaiwara
AL BU SHAMIS
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Hamra
Sa'afuk
As Suwan
'Uruq bin Tamaisha
Ramlat Ghafa
Umm as Samim
W. al Ajmain
W. Muaalhire
Adaba
Ghulfan
Wasa'
Nuwasif
Nasif
Hadh Mazariq
Karsua
Umm Malissa
Ramlat Umm Bakhur
Qarn as Sahama
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Khalat
Waterless stony plain
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Hadh Sabha
Ramlat Umm at. Tabul
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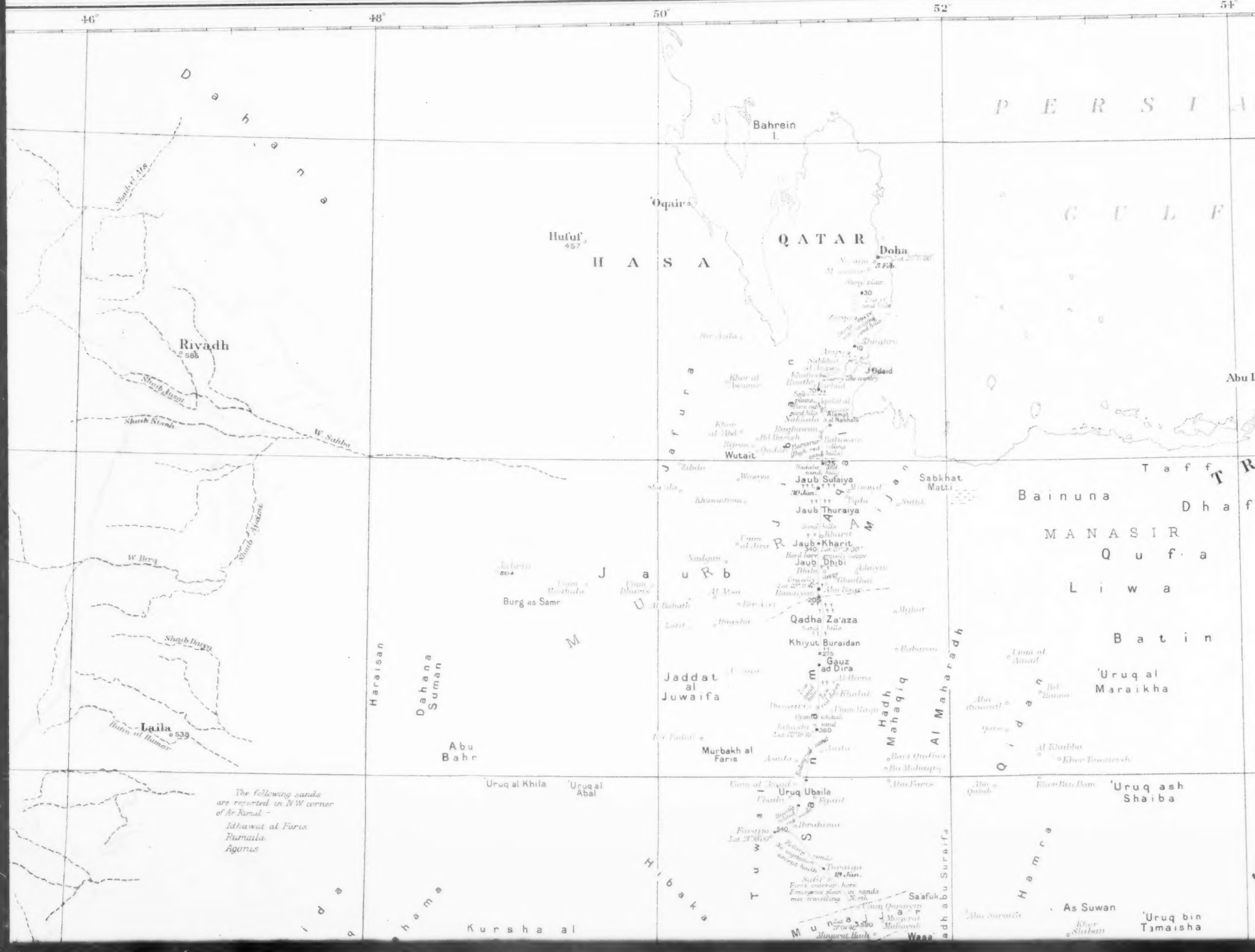
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Jaub Thuraiya
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Shaib Dagga
Laila
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Batn al Hamar
Burg as Samr
Qadha Za'aza
Khiyut Buraidan
275
Gauz ad Dira
Jaddat al Juwaifa
Haraisan
Dahana Suman
Abu Bahr
Murbakh al Faris
Hadh Mahaqiq
Al Maharadh
Qidan
'Uruq ash Shaiba
The following sands are reported in N.W. corner of Ar Rimal:-
Idhawat al Faris
Rumaila
Agonus
'Uruq al Khila
'Uruq al Abal
Uruq Ubaila
540
Saafuk
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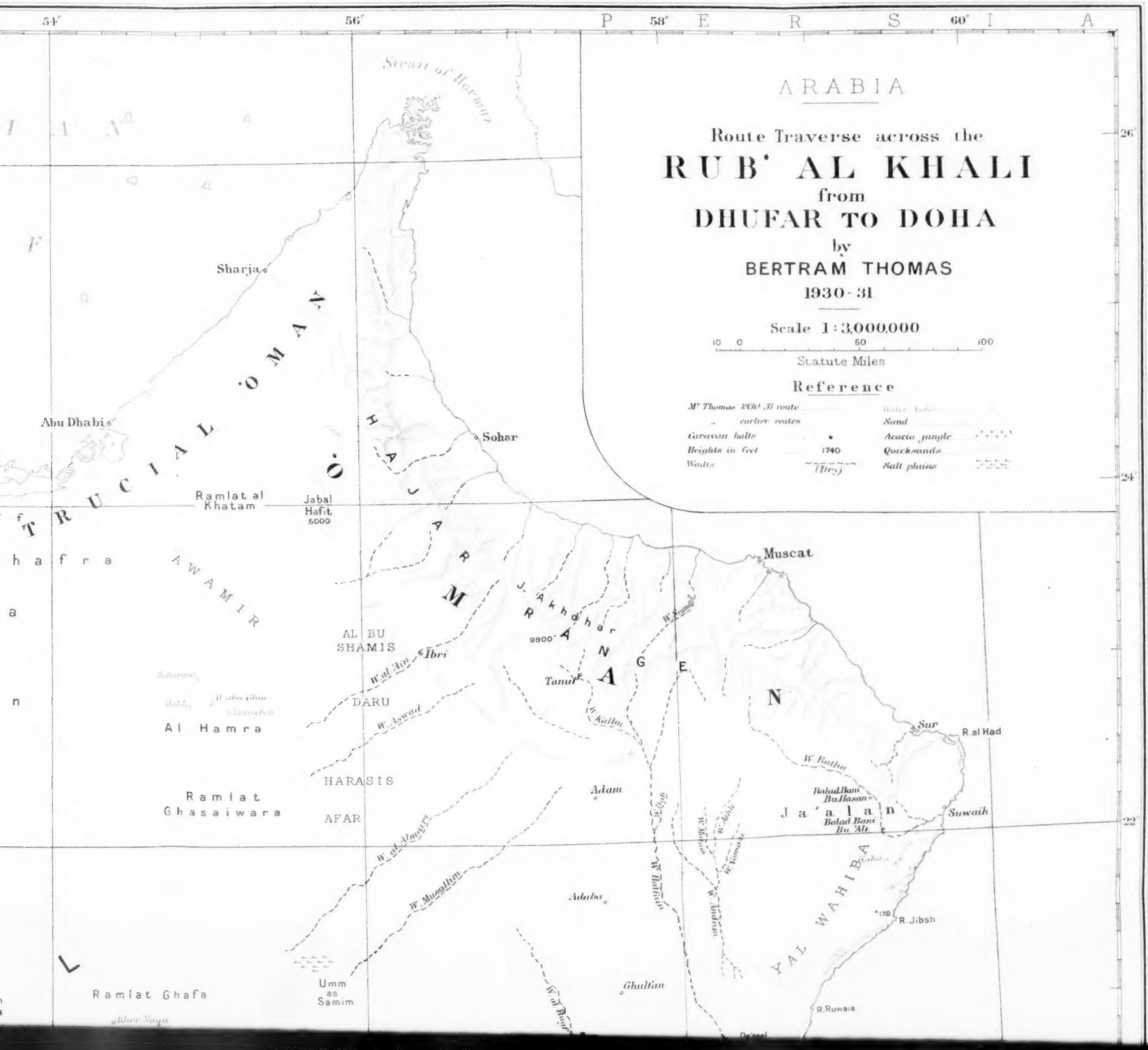
As Suwan
'Uruq bin Tamaisha
Kursha al
Hamra



ARABIA

Route Traverse across the
RUB' AL KHALI
from
DHUFAR TO DOHA
by
BERTRAM THOMAS
1930-31

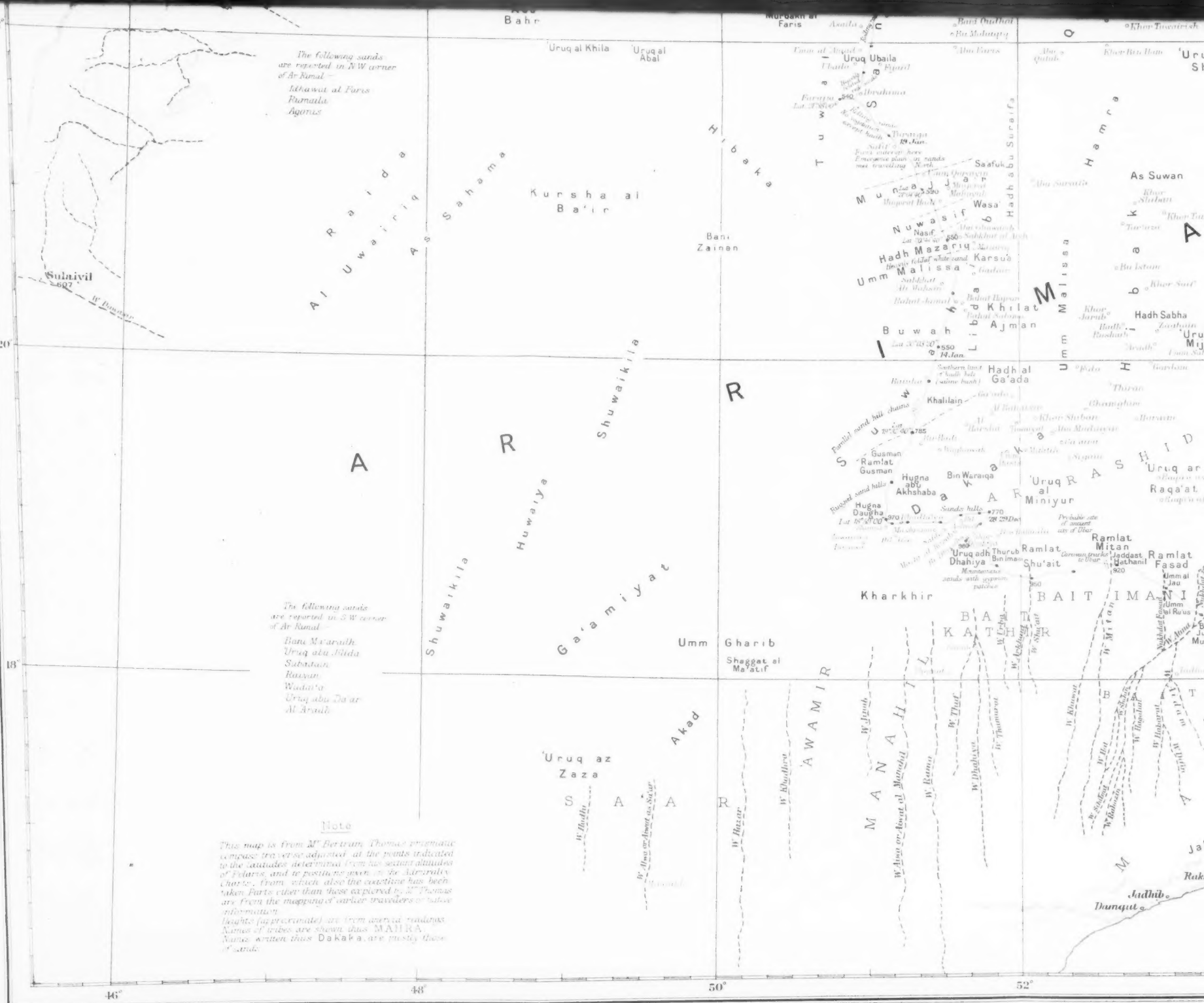
Scale 1:3,000,000

10 0 50 100

Statute Miles

Reference

Mr Thomas' 1930-31 route		Water holes
" earlier routes		Sand
Caravan halts	•	Acacia jungle
Heights in feet	1740	Quicksands
Wadis	(Dry)	Salt plains



Central Projection with true meridians and standard parallels 18° and 22°

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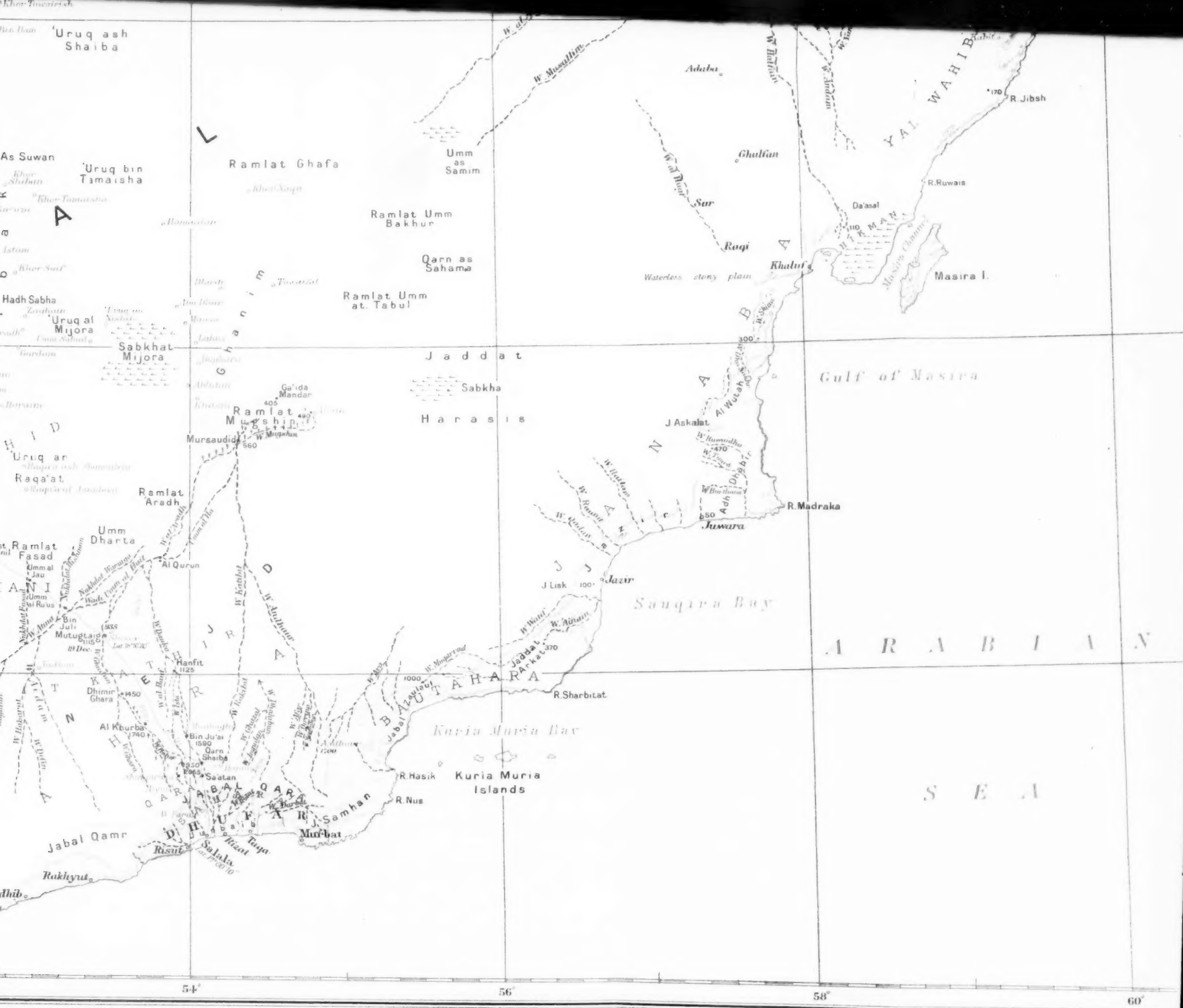
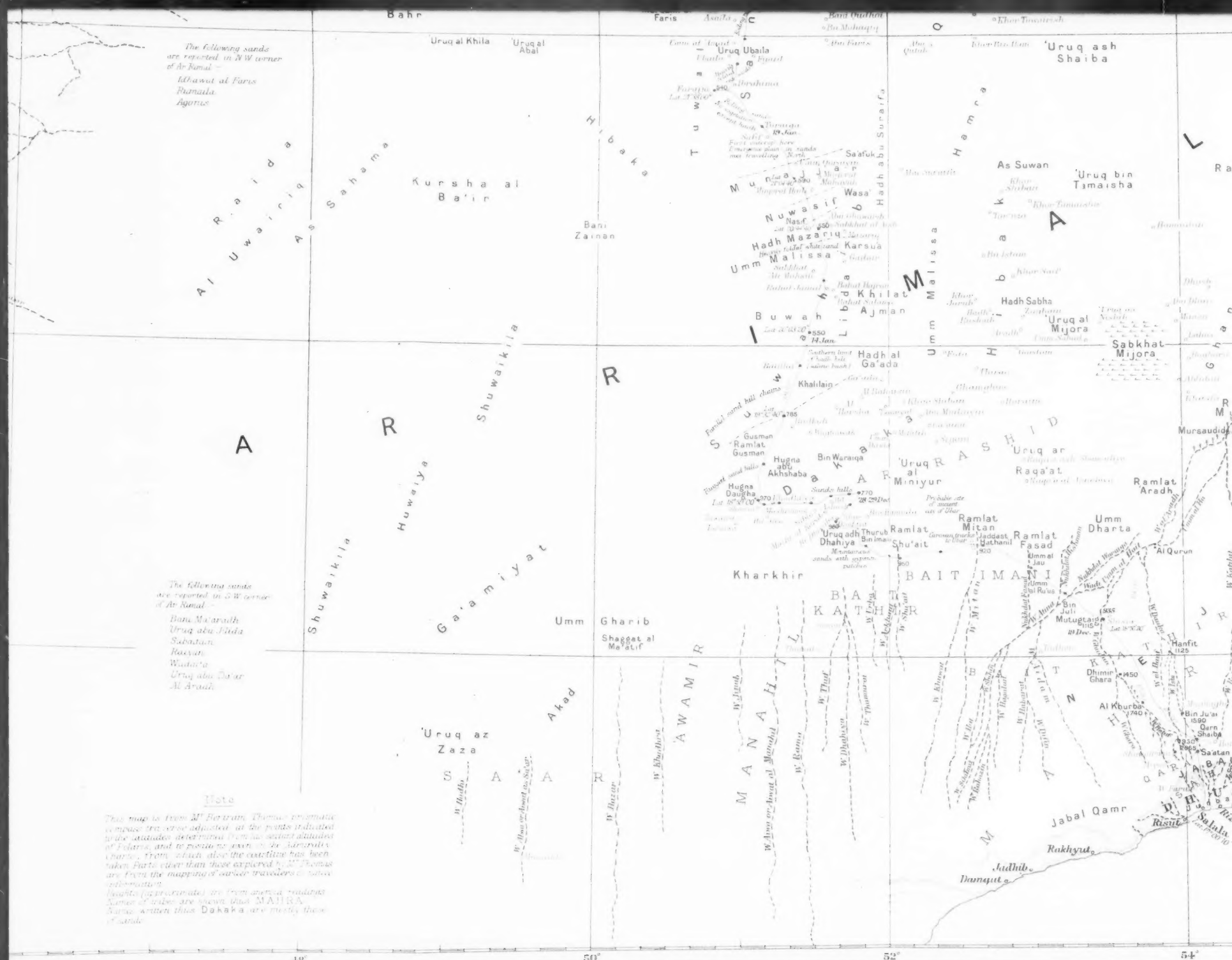


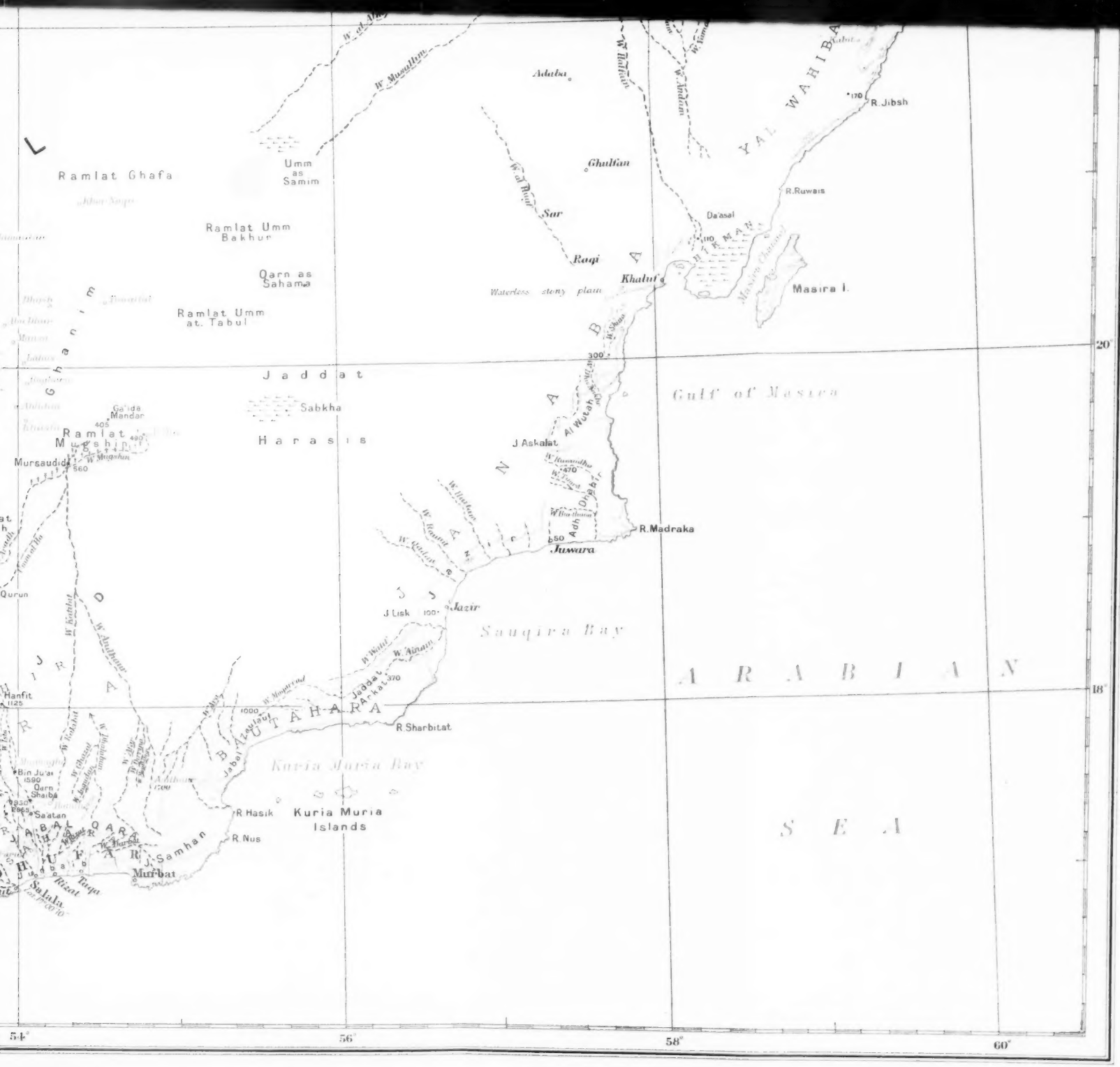
e Royal Geographical Society

SOUTHERN ARABIA
Thomas



True meridians and standard parallels 20° and 24°

Published by the Royal Geographical Society



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